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PEN+: An Emotional expression device and a mobile application for emotional health

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PEN+:

An Emotional expression device and a mobile application for emotional health

by Mi-hee Hong

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of Master of
Fine Arts in Industrial design

School of Design
College of Imaging Arts and Sciences

Rochester Institute of Technology
Rochester, NY

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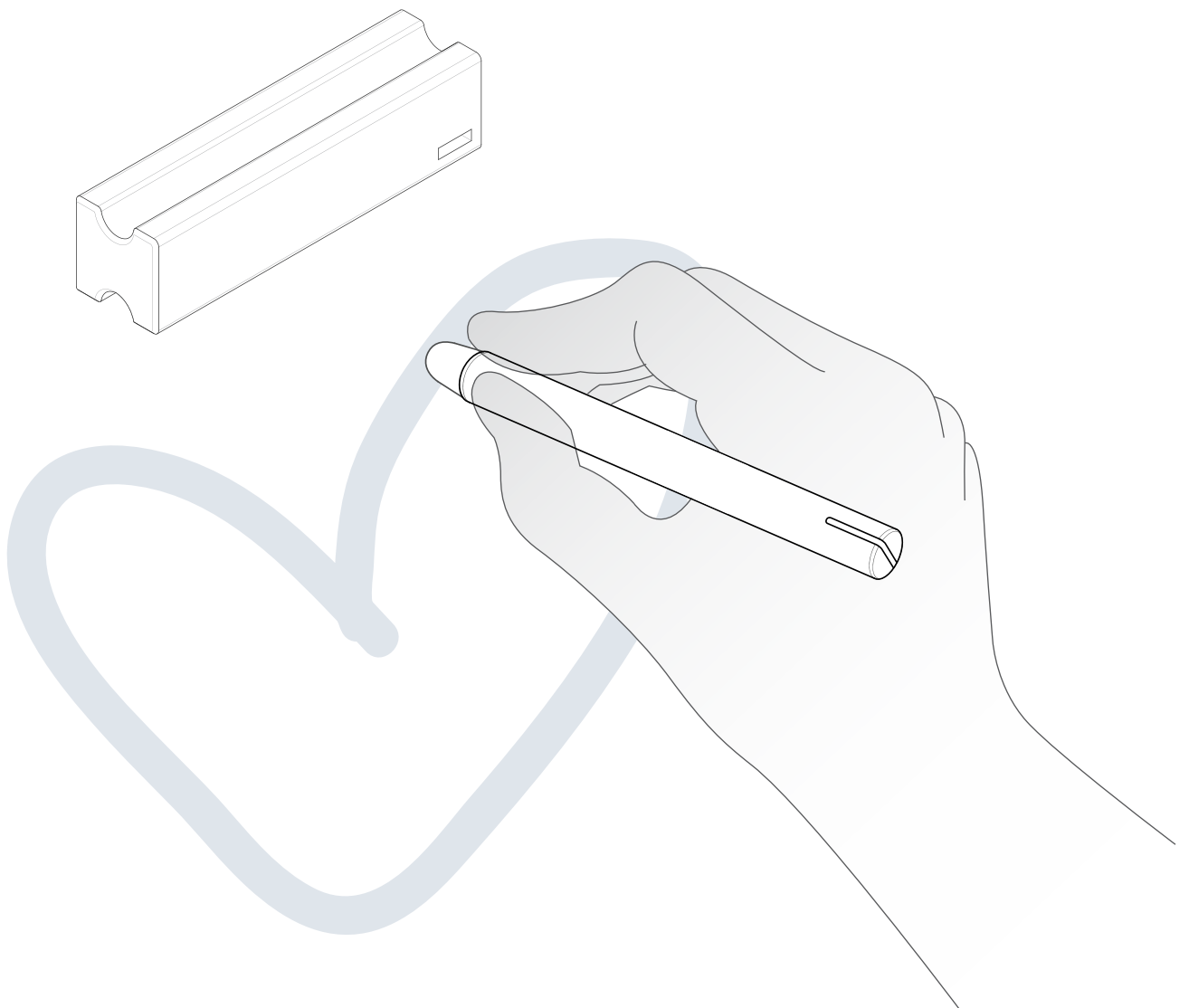


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Abstract

Emotional health is an essential element in advancing towards one's life goals and is inextricably connected with physical and social well-being. Since emotions involve physiological, behavioral, and cognitive changes, emotional problems can cause serious problems throughout one's life.

Understanding one's emotional states precisely and suitably expressing emotions are the most salient methods for maintaining emotional health. However, managing and comprehending complicated changes in emotions can be personally challenging and demanding.

This thesis not only concentrates on the process of design thinking to determine how to enhance personal emotional intelligence but also proposes the use of both a digital device for expressing emotions properly and a mobile application for having a better awareness of one's emotional state. The intent of this study is to offer these new designs through an integrated process to improve emotional health in daily life.

Acknowledgements

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Most of all, I am deeply indebted to my father, mother, sister, grandmother, brother-in-law, and nephews for all their constant supports, unconditional love, and encouragement.

PEN+

An Emotional expression device and
a mobile application for emotional health

Chapter 01

: **Introduction**

Personal experience

Purpose of the study

Chapter 01

: Introduction

Personal experience

Interest in human emotions started from personal experience. The earliest questions are what emotions are and how and why they influence life. We feel a variety of emotions in different situations. We experience either pleasurable or unpleasurable emotions in our ordinary events, and these emotions have an impact on daily life. In the first year I stayed in the United States as a student, I had a hard time adjusting to living in a foreign country. The cultural and linguistic differences created challenges in both school and daily life. These problems made me depressed, and I lost confidence, and at that time, I did my assignments slowly and incompletely. However, I became accustomed to living in a foreign country, and I could do my work well again. The change of circumstances had had an influence on my emotions and vice versa.

The second question is about different emotional expressions to others. When we communicate with others, we expose our emotions or feelings through words, facial expressions, or gestures, whereas they hide those to others. There are two examples of personal experience of a different way to deal with emotions or feelings. One day, I experienced discomfort because my neighbors had a loud party late at night. The next day, I frankly expressed the emotions that I had felt while I talked with my friend about what happened yesterday. She empathized and listened to my story. After this conversation, I could relieve my negative emotions (Figure 1). I talked with my mother on the phone about the same topic. I lightly explained yesterday's episode without any emotional expression because I didn't want her to worry about me for insignificant things. Even though I hid my emotions for that reason, talking with her was enough for me to be comfortable (Figure 2). We felt and expressed our complex emotions differently than in daily life. Sometimes we show our emotions frankly to others, whereas we hid or controlled

these.

Through these personal experiences, I understand why emotional expression is different and how to express emotion differently.

As shown in Table 1, emotional expression can differ depending on personality, interlocutor, and situation. These factors may affect the way one expresses emotions: hiding or controlling emotions and revealing or sharing emotions with others. One of the interesting points in this assumption is that concealing emotions is one of the ways to display emotions. Another important aspect of emotional expression relates to social environments.

Table 1. Assumption of different emotional expression

| Expressing Emotion | | |
|--|--|---|
| Different | | |
| Why | How | |
| Personality Interlocutor Situation | Hide / Control | Reveal / Share |
| | Why No need On purpose Respect other's feeling | How Manage facial expression Change tone Change the topic |
| Time Place Position Communication channel | Why | How |
| | Out of control Wanting On purpose | Facial expression Gesture Voice Tone |



Figure 1.
Personal experience example 1



Figure 2.
Personal experience example 2

Purpose of the study

There is no doubt that physical and mental health are the important component in life. Recently, the interest in mental health has increased more and more. Also, many researchers in different fields have subscribed to the view that emotion has a pivotal role in mental health. Besides, these days, we frequently hear news about social issues caused by emotional disorders or disturbances. A typical example of this is the accidents and incidents caused by road rage, which is the violent tendency that occurs from a disturbance in anger management while driving. Also, problems such as suicide or social isolation caused by depression have increased. The issues with emotions have been repercussions for the whole society.

There are many issues about human emotions besides personal questions such as what emotions are, why and how emotions influence life, and why and how emotions are expressed. This study will discuss many issues about human emotion and will suggest innovative and substantial designs for improving emotional health.



Chapter 02

: Emotion

Emotion

Frameworks of emotion

Emotional expression

- Facial expression
- Vocal expression
- Written expression

Impact of emotion

- Emotion and social issues
- Emotional well-being

Chapter 02

: Emotion

This chapter provides a brief overview of emotions, expressions for emotions, and the impact of emotions. There are significant volumes of published research about emotions. This study focuses on learning about common knowledge of emotions so that a basic understanding guides the right direction of the final goal of this study.

Emotion

The question of human emotions has consistently been raised by psychologists, scientists, and many researchers in different areas. In history, some philosophers regarded emotions as the obstacles of rational judgment and felt emotions should be moderated, but Aristotle maintained that emotions have influenced moral beliefs or thoughts (Solomon, 1999). Emotions have been distinguished from reason and had considered as mental affection.

20th century, the study that explains the mechanism of emotion in psychological phenomena had turned out. James (1984) stated that emotion is the feeling of bodily changes which results from the perception of exciting facts. However, Cannon (1927) argued that subjective feelings of emotions are irrelevant with physiological changes. Also, there are other views as emotions depend on the assessment of situations (Lazarus, 1984). This study will present frameworks of emotions in the following section.

Emotions are the valuable part of our lives. In daily life, we use terms of feelings, emotions, moods, and affections without distinction. However, in psychology, these terms are used differentially. It is hard to define such terms simply, but definitions are needed to distinguish them and comprehend more about emotions. Although an abundance of analyses and research on emotion exists and is continually in progress, each definition of emotion is little different.

Davidson (2003) encapsulated emotion as being a “feeling,” “mood,” and so on (Table 2). He defined emotion as “a relatively brief episode of coordinated brain, autonomic, and behavioral changes that facilitate a response to an external or internal event of significance for the organism.” In other words, emotion is made of short instinctive responses to an internal or external event that is verbal, behavioral, or neural. Davidson defined feeling as being the subjective representation of emotions and mood as a diffused affective state with a long duration. The word “affective” refers to the phenomenon of entire emotions, feelings, and moods together and is interchangeable with emotion (Fox, 2008). This study will research more about emotion instead of feelings and moods because the intent of the research is to find a solution to improving emotional health.

Table 2. Phenomena include under the rubric of ‘affective science’ as outlined

| Affective phenomena | Definition |
|---------------------|---|
| Emotion | A relatively brief episode of coordinated brain, autonomic and behavioural changes that facilitate a response to an external or internal event of significance for the organism |
| Feeling | The subjective representation of emotion |
| Mood | A diffuse affective state that is often of lower intensity than emotion, but considerably longer in duration |
| Attitudes | Relatively enduring, affectively coloured beliefs, preferences and predispositions toward objects or persons |
| Affective style | Refer to relatively stable dispositions that bias an individual toward perceiving and responding to people and objects with a particular emotional quality, emotional dimension or mood |
| Temperament | Affective style that are apparent early in life, and thus may be determined by genetic factor |

Source: adapted from by Davidson et al. (2003) and Fox (2008)

Emotion consists of different components. Scherer (2001) described five important factors and examined their relationship with organismic subsystems and functions (Table 3). He argued that these five components of emotion have specific functions, and all of them can be coordinated for a short time. Although there are some disputations with Scherer's view, the author has ably explained a type of synchronization involved in emotional episodes. His perspective has contributed to the concept of measuring emotions according to this theory of the five factors.

Table 3. The relationship between the components of emotion and the organismic subsystems and functions of emotion

| Emotion component | Organismic subsystem | Emotion function |
|---|------------------------|---|
| Cognitive component (Appraisal) | Information processing | Evaluation of events and objects |
| Neurophysiologic component (Bodily symptoms) | Support | System regulation |
| Motivational component (Action tendencies) | Executive | Preparation and direction of action |
| Motor expression component (Facial and vocal expression) | Action | Communication of reaction and behavioural intention |
| Subjective feeling component (Emotional experience) | Monitor | Monitoring of internal state and organism-environment interaction |

Source: adapted from Scherer (2001) and Fox (2008)

Frameworks of emotion

This section studies frameworks of emotions from four different theories that help to understand why people experience emotion. The first theory is the James-Lange Theory (1884-1887). According to this theory, when people are externally stimulated, physiological changes occur. Then they experience emotion after interpreting these changes. For example, a woman is getting in an elevator. Suddenly, the elevator stops, and her heart beats faster and she is out of breath. She construes this terrible situation, and then she feels fear (Figure 3).



Figure 3. James-Lange Theory (1884-1887)

Source: adapted from <http://allpsych.com/psychology101/emotion/>

The second theory is the Cannon-Bard Theory. Cannon (1927) disagreed with the James-Lange Theory. He stated that physiological arousal and emotion occur simultaneously when people experience an event. For example, a woman is in the same situation mentioned above. When the elevator stops, she experiences high heart rate and choking and feels fear at the same time (Figure 4).

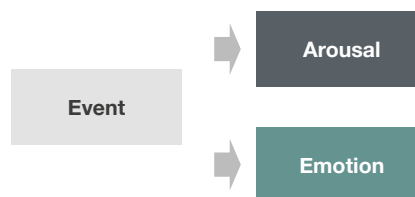


Figure 4. Cannon-Bard Theory (1927)

Source: adapted from <http://allpsych.com/psychology101/emotion/>

According to the Schachter-Singer Theory (1962), the event causes physiological arousal, and then people ratiocinate the reason for arousal. After that, they feel emotion. For example, a woman is in the stopped elevator and she experiences bodily changes. She notices that the dangerous situation caused these changes, and then she feels fear (Figure 5).



Figure 5. Schachter-Singer Theory (1962)

Source: adapted from <http://allpsych.com/psychology101/emotion/>

Lastly, the Lazarus Theory (1966) mentioned that stimuli caused by the event go through cognitive processing, and then people experience physiological and emotional changes. For example, one woman thinks being in a stopped elevator is a dangerous situation, so her heart rate rises and she experiences fear (Figure 6).



Figure 6. Lazarus Theory (1966)

Source: adapted from <http://allpsych.com/psychology101/emotion/>

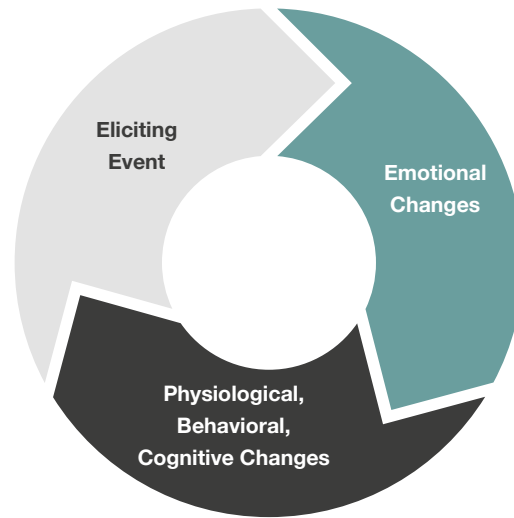


Figure 7. A circular process of emotions

Each of these theories has a different view of the process of experiencing emotion from an event. However, there is a common point at which the eliciting event causes emotional changes. As studied, emotions accompany physiological, behavioral, and cognitive changes. Thus, this study assumes that the process of experiencing emotions may explain the circular process instead of the linear process (Figure 7). In other words, eliciting events affect emotional changes, which affect physiological, behavioral, and cognitive changes that affect daily life. Also, emotional changes may influence themselves on the new emotion. Thus, emotion is essential because of the infinitive circular process.

Emotional expression

The previous section discusses emotion and the process of experiencing emotions, which one may be regarded as the internal processing of emotion. This section discusses the expression of emotion, which may be regarded as the external process of emotion.

Expressing emotion may be different from experiencing emotion. This study presumes that the latter is the inner response to external stimuli and the former is the outer response, which comes from internal motivation. As mentioned previously, the experience of emotion is influenced by physiological, behavioral, cognitive change. On the other hand, the expression of emotion has an influence on the quality of interpersonal relationships (Salovey, Bedell, Detweiler and Mayer, 2000). One's emotional expression can be an eliciting event to others. For example, if a man experiences a terrible event and he is upset, then he yells loudly on the street, where a young girl is walking. She is scared and starts to cry because of his loud voice. Kennedy-Moore and Watson (1999) state that it is disadvantageous not to express one's emotion, or to express one's emotions inappropriately. Although the emotional expression is complicated because of its essence, namely, it could be strategic, spontaneous, or private, the expression of emotion can be managed (Guerrero, 1988). Managed or regulated emotional expression helps people to maintain a good relationship with others. Furthermore, emotional expression is fundamental to well-being in daily life (Darwin, 1969).

Facial expression

Facial expression is known as the representative emotional expression. It is a kind of physiological reaction of emotions and it correlated with the central nervous system (Ekman, 1975).

Ekman (1975) remarked that facial expression embraces signals, as well as messages. The Arthur people can control facial expression by three signals — static, slow, and rapid. The static signal refers to the feature of a face such as skin tone, size, and so on. The slow signal means changes in facial appearances, such as wrinkles. The rapid signal is the temporary change in face, such as facial muscles.

He also claimed that facial expression carries messages about emotion, mood, intelligence, and so on. Thus, facial expression entails many things so that people understand correctly or misjudge emotions. Facial expression may be the good and fast way to convey one's emotion to others. Likewise, a mother smiles warmly to a baby who responds with a smile.

Vocal expression

Vocal expression of emotion is based on sound production. It can be divided into two aspects, nonlinguistic vocalization and vocal expression in speech (Russell, 2003). Nonlinguistic expressions, such as laughter and cries, are vague determinants of emotions (Russell, 2003). People may laugh loudly when they are amused or angry. Russell (2003) stated that vocal expression is different with different stimuli. Different patterns of vocal expression are related to the sender, but it is hard to maintain that each pattern is linked with discrete emotions.

Written expression

There is no doubt that writing is the common way to represent one's thoughts, ideas, or beliefs and to impart information and record events, such as history. When people write, they tend to think more than when they talk. People search for words to convey an idea correctly or to summarize a story to be funnier or more accurate. Pennebaker (1991) believed that the action of writing, in itself, can improve physical and mental health. However, unlike emotional facial expressions, it is hard to express emotions immediately because writing about emotions or events causes emotional change that may require the cognitive process. When people find it difficult to express emotion, writing can be a good way to express and refresh emotions.

Impact of emotion

As mentioned before, emotions correlate the internal and external human factors and are intricately linked with human life. The connection between psychological stress and physical disease can be explained through emotion (Cohen and Pressman, 2006).

Emotion and social issues

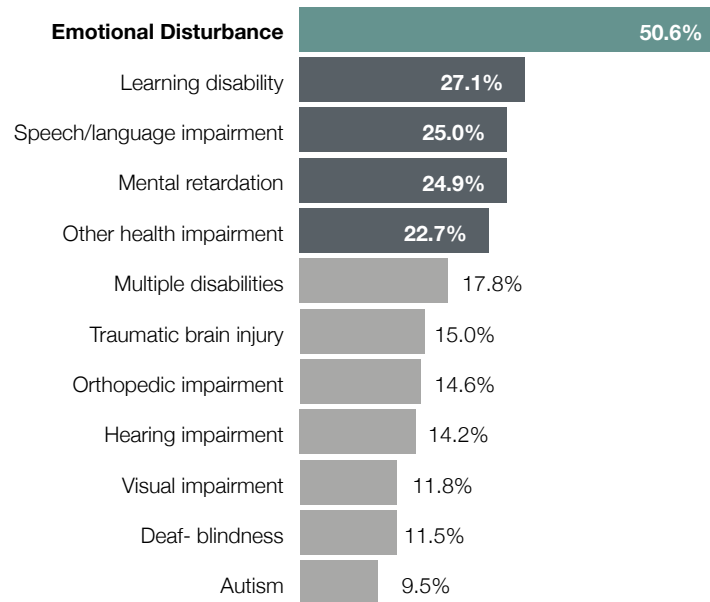
Many researchers tended to focus on the negative aspect of emotion in the past because the impact of negative emotions showed as the social phenomenon. Anxiety or depression is deeply associated with morbidity and mortality (Cohen and Pressman, 2006). Statistical data about depression illustrates the seriousness of the problem.

According to the American Association of Suicidology, 60% of people who committed suicide had a depressive disorder, and people with major depression are 20 times more at risk of suicide. These problems are caused by the failure of regulation of negative emotion.

There are other problems caused by the failure of regulating overall emotions; emotional disturbance is a common example. Chart 1 shows that 50.6% of students age 14 and older who dropped out school replied that they dropped out school owing to emotional disturbance. This material can be interpreted that emotional problem has more effects on social or interpersonal relationships than physical and academic or intellectual problems. Emotional disturbance or emotional behavior disorder can be found among young people.

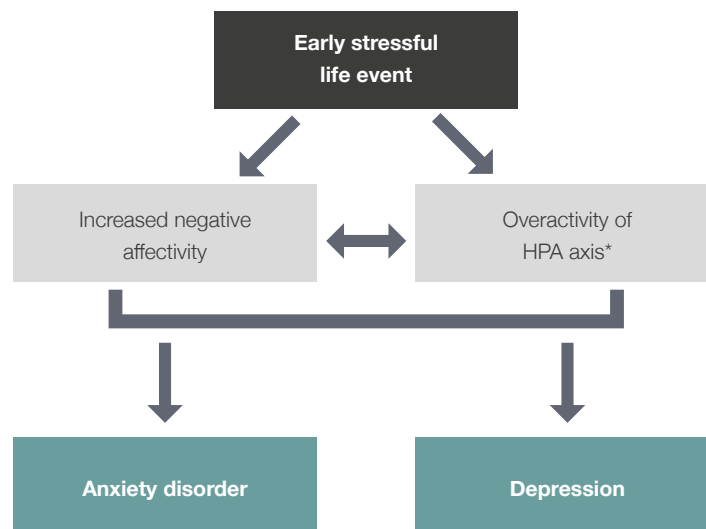
As shown in the figure 8, a stressful life event arouses negative affectivity and abnormal action of the pituitary gland, and these effects can be catalysts to experience anxiety disorder and depression (Fox, 2008). The emotional problems in early life give rise to problems of social adaptation, interpersonal relationship, and personality in adulthood. Likewise, problems caused by emotion tend to be considered to occur from negative emotions.

Chart 1. Number and percentage of students age 14 and older with disabilities who dropped out, by selected disability categories



Source: U.S. Department of Education, OSERS (2001), Table I-1

Surveys: U.S. Department of Education, OSEP, Data Analysis System, 1998-99



*HPA axis is hypothalamic-pituitary-adrenal axis

Figure 8. Possible mechanism underlying the relationship between stressful life events experienced in childhood and the development of subsequent emotional disorders

Source: adapted from Fox (2008)

However, negative emotions can be the source of change among people. Table 4 shows that both positive and negative emotional valence are motivations to change (Linda, Levine, David and Pizarro, 2004). Experiencing a negative emotion can be a good stimulation to change thoughts or plans and to overcome bad situations. For example, a male student fails to pass the test and feels regret. He then decides to study more and to take the test again. There is no doubt that positive emotions are also good motivation for further development. Therefore, this study will regard both negative and positive emotions together rather than as separate emotions.

Table 4 Kennedy-Moore and Watson's (1999) Possible benefit and cost of emotional behavior

| Possible benefits of adaptive expression | Possible costs of maladaptive nonexpression | Possible costs of maladaptive expression |
|--|--|---|
| Arousal regulation | Suppression requires physiological work that may take cumulative toll on the body. | Extreme or unrelenting expression may intensify or prolong arousal to an unhealthy extent. |
| Self-understanding | Lack of awareness of distress hinder initiation of appropriate coping efforts. | Being overwhelmed by emotion interferes with clear thinking and hinders the use of emotional responses as a source of information about the self and the environment. |
| Coping/emotional processing | Effortful preoccupation with holding in feeling impedes coping effort and intensifies distress. | Passive preoccupation with emotion may interfere with ability to implement active coping effort. |
| Adaptive social communication | Inability to communicate feelings may interfere with the development of intimate relationships and the marshaling of social support. | Inappropriate expression may drive away potential or exiting social support. Violating social norms or personal values may evoke feelings of shame. |

Source: adapted from Kennedy-Moore and Watson (1999)

Emotional well-being

As previously mentioned, even negative emotions can be good motivation. However, these changes are not applied to all. For example, a male student who fails to pass the test feels regret. Then, his emotions may rise and become out of control. He may think of suicide. Although this illustration is exaggerated, no one can predict the range and direction of emotional changes. Thus, the skill of managing or modulating one's emotions is needed and is called emotion regulation (Gross, 1995). Emotion regulation does not state suppressing or hindering emotions; in this process, people may amplify, maintain, and repress their emotions (Parrott, 1993). Regulating emotions also occur consciously or unconsciously (Cole, 1986). People use different ways to regulate emotion as if they express their emotions through different channels. Although it is hard to say that emotion regulation is good or bad, it is an important way to manage one's emotion.

There is another area to describe the management of emotion, which is emotional intelligence. Emotional intelligence means the ability to recognize one's emotion and others' emotional state, and it helps people solve and cope with problems and advance life goals (Mayer and Salovey, 1990). Goleman (1995) insisted that emotional intelligence allows people to be satisfied with their lives by motivating them to put effort into achieving their goals by managing emotions by themselves. Also, the author argued that emotional intelligence supports people's good interpersonal relationships by dealing with the situation or others' emotions through understanding and empathizing with others' emotions. Therefore, managing emotions is essential to life satisfaction.

There is no doubt the positive emotions, such as joy, happy, excitement, and so on, give positive influences in life. The positive emotions impact physiological health, such as improved sleep quality, outdoor vigor-activity, promotion of hormone secretion, and so on (Pressman and Cohen, 2005). Moreover, positive emotions can encourage creative activities (Fredrickson, 1998).

Happiness is one representative of positive emotions and can be regarded as the scale to determine the quality of life. However, the degree of life satisfaction differs individually. Likewise, one's life satisfaction and happiness are based on personal and subjective experience, which is called subjective well-being (McDowell and Newell, 1990). Diner (1984) maintained that positive and negative emotion from objective experiences or situations and the degree of subjective satisfaction determine the quality of life. Therefore, individual emotional experience has the important role in making life worth it. However, we cannot feel only happy or satisfied with events every day. We also need to manage or modulate emotions to be emotionally healthy. Managing emotions would enable understanding one's emotions, which would be accompanied by adequate expression.

Therefore, this study focuses on finding the proper solution to improve life quality though being emotionally healthy. Moreover, this study concentrates on suggesting new designs for products or services to achieve the proper ways of understanding and expressing emotions.



adorable



Chapter 03 : Target user

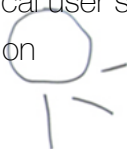
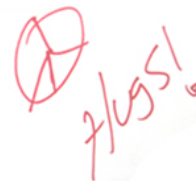
Target user

Demographics

Hypothetical user scenarios

Observation

Survey

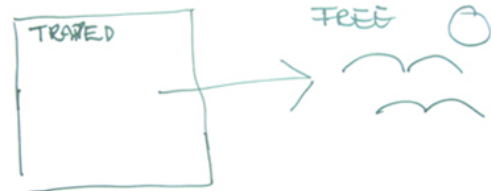


Feeling confused... I don't know what I have to do with my life - Wish should be my next step... But I'll fix it. ☺



♥ NY

STRESS



PEN+An Emotional expression device and a mobile application for emotional health

I need more \$\$\$

Chapter 03

: Target user

This chapter presents four methods for selecting and exploring prospective users for this study. The issues related to emotions are very broad and complex as mentioned in the previous chapter, thus it was necessary to narrow down the range of target users to identify their problems and suggest a better solution.

The first method of determining the potential user was to study statistics on mental illness because mental health has relevance to emotional health, although with some differences. The next approach was a hypothetical user scenario that helped to anticipate problems with emotions in daily life. The third way was observation, to discover people's hidden characteristics and needs. The last method to research target users was conducting a survey to gather information about emotional expression. These methods support research to identify potential users and to develop the design goals and objectives for this study.

Target user

One process to decide the target user is by using statistics on mental illnesses. Mental illness is common in the United States. The Substance Abuse and Mental Health Services Administration (SAMHSA) reported that about 20% of adults aged 18 or older in the United States had a mental illness in 2012. According to the U.S. National Survey on Drug Use and Health (NSDUH), in 2011, about 45.6 million adults aged over 18 had any mental illness (AMI) and an estimated 11.5 million adults aged 18 or older suffered a serious mental illness (SMI). NSDUH defines AMI and SMI as mental, behavioral, or emotional disorders within the 4th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), but persons with SMI have significant problems or limits on their life activities (SAMHSA, 2012).

In 2011, the highest percentage of adults with AMI was age group 18 to 25, followed by age group 26 to 49 (Chart 2). Also, the largest proportion of persons with SMI was age group 18 to 25, followed by age group 26 to 49 (Chart 3). Thus, this study chose persons aged 18 to 25 years old as target users.

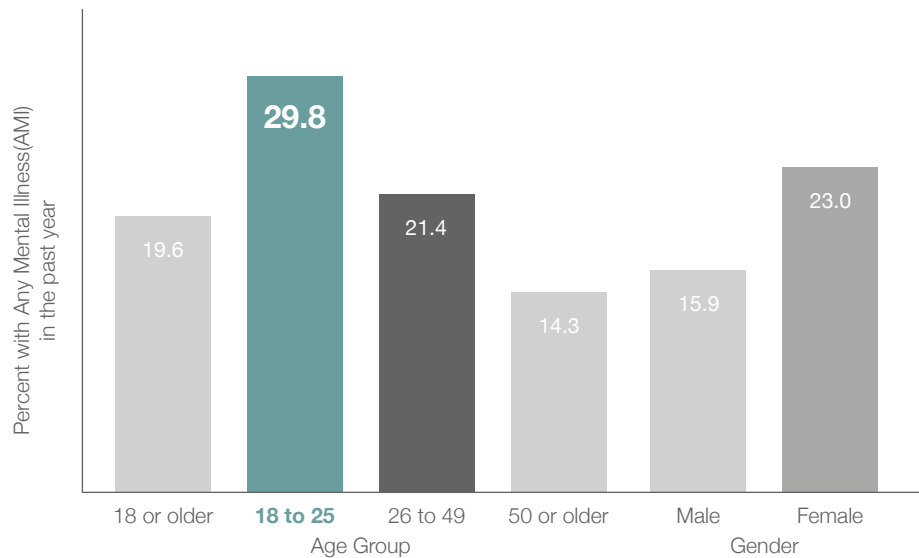


Chart 2. Any Mental Illness in the past year among adults aged 18 or older, by age and gender: 2011
Source : Adapted from National Survey on Drug and Health: Mental Health Findings (2011)

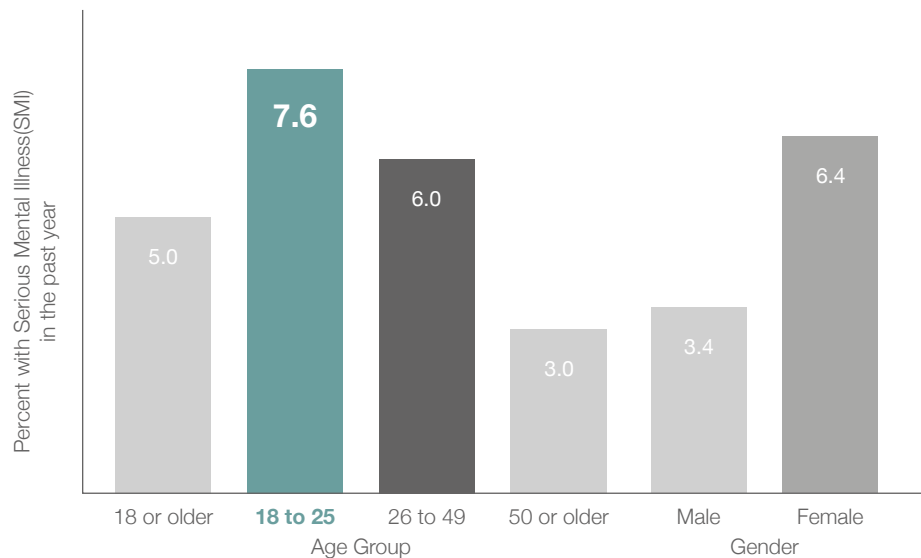


Chart 3. Serious Mental Illness in the past year among adults aged 18 or older, by age and gender: 2011
Source : Adapted from National Survey on Drug and Health: Mental Health Findings (2011)

Demographics

Through demographics, this study identified features of the target user. According to the U.S. Bureau of Labor Statistics (BLS), nearly 69.5% of youth 16 to 24 who had graduated from high school were enrolled in college in 2013 (Chart 4). Also, 34.1% of students enrolled in college in 2013 participated in economic activities (Chart 5). Average time-use statistics for university students in 2010-14 (Chart 6), showed that they spent 3.3 hours on educational activities and 2.4 hours working or on related activities. That meant that they needed to be at a certain place with others for the purpose. Moreover, they consumed about an hour for personal grooming. This suggested that they might be interested in the latest trends and were likely to be self-conscious. They also spent 4.1 hours in leisure and sports, which implied that self-development and interpersonal relationships were valuable to them.

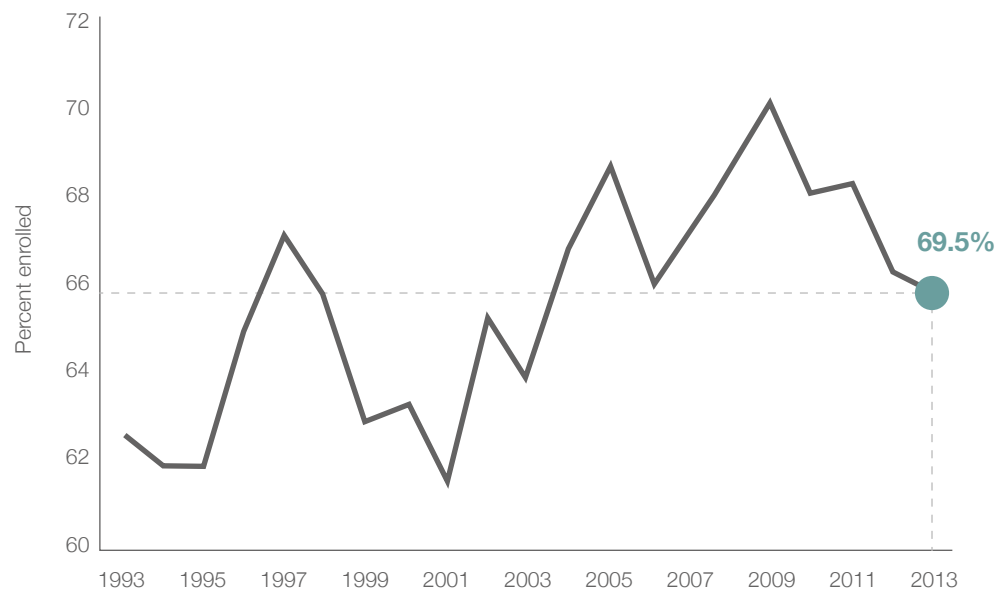


Chart 4. Percentage of 16- to 24-year-olds enrolled in college during October of the year they graduated from high school

Source : Adapted from U.S. Bureau of Labor Statistics.

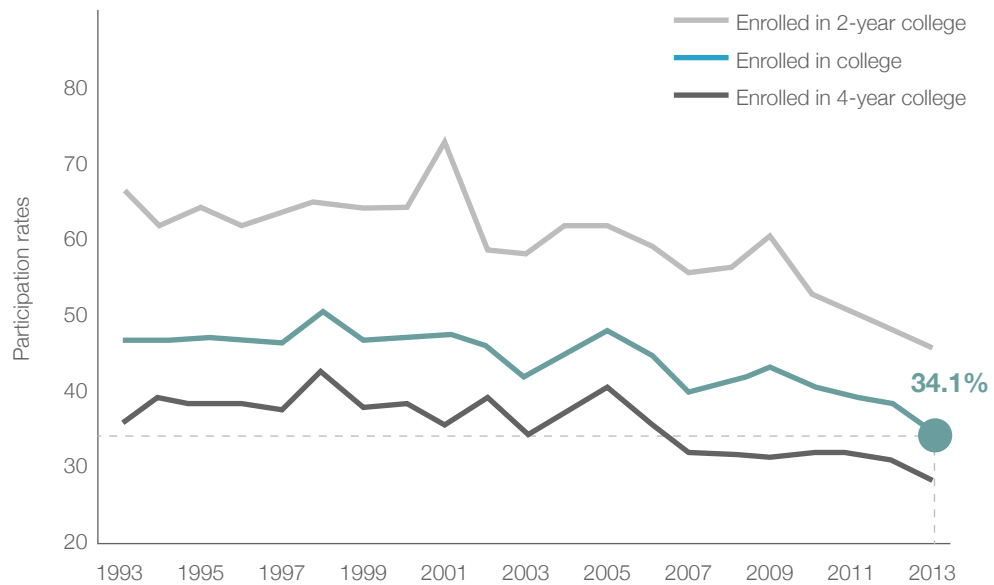


Chart 5. Labor force participation rates of 16- to 24-year-olds enrolled in college during October of the year they graduated from high school

Source : Adapted from U.S. Bureau of Labor Statistics.

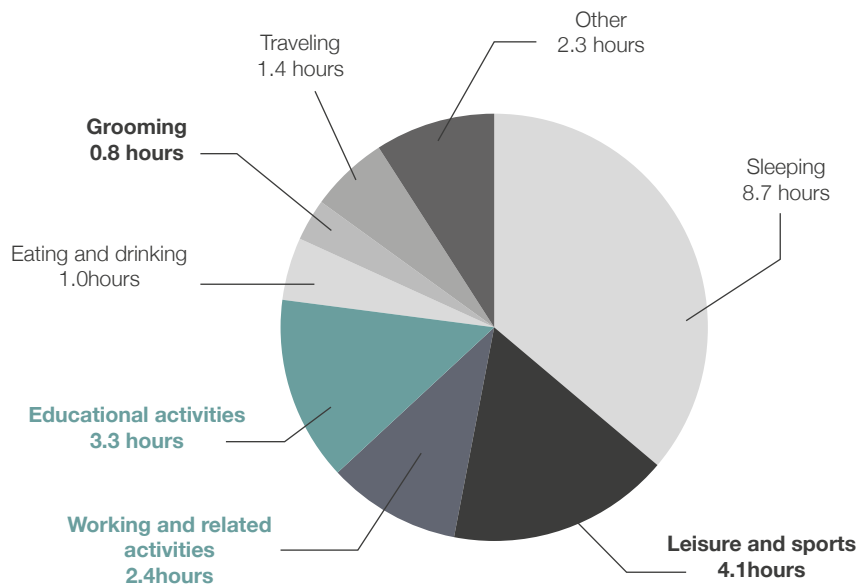


Chart 6. Time use on an average weekday for full-time university and college students

NOTE: Data include individuals, ages 15 to 49, who were enrolled full time at a university or college.

Data include non-holiday weekdays and are averages for 2010-14

Source: Adapted from Bureau of Labor Statistics, American Time Use Survey

This section illustrates different hypothetical user scenarios. Various types of potential user in scenarios presumed adult aged 18 to 25 and student or worker. These conceivable anecdotes indicate contradistinctive situations where people displays their emotions differently according to times, places, and occasions.

Hypothetical user scenarios 1



Figure 9. Heavy task in work
(Hypothetical user scenarios1)



Figure 10. Coffee break
(Hypothetical user scenarios1)

This scenario shows a plausible account of a man who is at a workplace with coworkers. He works hard and has a good interpersonal relationship with colleagues. Then one day, he got a tremendous stress because of the heavy workload. He could not focus on his project and thereby be getting anger. However, he could not express his anger honestly during working with work fellows because he thought it is not right attitude at work. So, he drank a cup of coffee and took a short rest to control his emotions. Then he returned to work. This scenario indicates that emotional expressions and behaviors are regulated in a given situation. As Thomson (1994) state, emotional reactions to stimuli can be amplified, reduced, or maintained. Children steadily become accustomed to restrain their satisfaction by social expectations under the effortful control strategies (Kopp, 1982). Similarly, a man in this scenario selected his ways to repress his emotions instead of a way to express his emotions because of social expectations.

Hypothetical user scenarios 2



Figure 11. Having lunch in restaurant
(Hypothetical user scenarios 2)



Figure 12. talking with friend
(Hypothetical user scenarios 2)

The second possible scenario is a story about casual situation. A female college student has a good time with her close friend while having lunch at their favorite restaurant. Foods are delicious and atmosphere of the restaurant is comfortable. She feels happy and smiles and her voice is cheerful. When talking about funny her episode of school life, she and her friend laugh loudly and clap their hands. This scenario describes various emotional reactions through different ways: facial, vocal, and postural. The face is a visual channel to send emblematic messages rapidly (Ekman, 1975). She used words to explain her emotions; her smiley face may transmit information of her emotional state. Additionally, emotional expressions may be uncontrolled unconsciously depending on the circumstance and partner, like she laughs loud.

Hypothetical user scenarios 3



Figure 13. Reading book
(Hypothetical user scenarios 3)



Figure 14. Taking rest
(Hypothetical user scenarios 3)

Lastly, it is a situation where a woman is alone at home after a daily routine. She relaxes with reading a book in the bed. The book is the story of Hachiko, a dog, who waiting for his owner every day at the same place. She recalls her She recalls time when she used to play with her puppy, as well as her pleasant emotions at that point. She smiled when seeing picture with her dog on her laptop. Then she went to sleep. Her recollection process in this scenario shows that emotion may impact on memory (Parrot and Spackman, 2000). Occasion with emotional experience can be stored minutely and recalled easily.

Observation

This approach to understanding target user is the observation. It is expected to discover intriguing factors by monitoring them. Observed subjects are students and staffs in the Wallace Library at Rochester Institute of Technology (RIT). Many students are studying alone or having a meeting with classmates. Some of them study for a long time and another circulate.

There are two interesting results of observation research. The first interesting thing is one's belongings. Because subjects under observation are students, most of their belongings are small electronic products such as smartphone and laptop. Some of them also possess books, stationery, or food and drink (Figure 15).



Figure 15. Belongings of students in the Wallace Library at Rochester Institute of Technology (RIT)

The second attractive result after monitoring their surroundings is scribbles. While watching people's behaviors, lockers in which there is big graffiti on the door. Scribbles are everywhere around school, such as on the wall, on the desk, and even on the door in restroom. Some of scribbles include message or opinion of creator and another has many replies. Most of scribbles around school are straightforward and abstractive drawing painted with various type of writing tools (Figure 16).



Figure 16. Various scribbles at Rochester Institute of Technology (RIT)

Survey

The primary aim of the section is to inquire into an information of understanding about a general expression of emotions in daily life. The questions of this survey are based on a study of emotional experience process in Chapter 2. Also, this survey focuses on how people portray their emotions with a writing tool.

The respondents of a various age group answered this questionnaire in New York City from May 28th to 29th, 2012. Among them, about 64 % of participations between the age of 19 to 29 years old were selected to develop target research.

The total of 39 people participated in this survey, and the majority of them was in their 20s. 52 %t of respondents was male and 48 % of them was female (Chart 7). According to the preselected potential user group, 25 respondents have selected to analysis the results of the survey (Chart 8).

Chart 7. Gender (Survey)

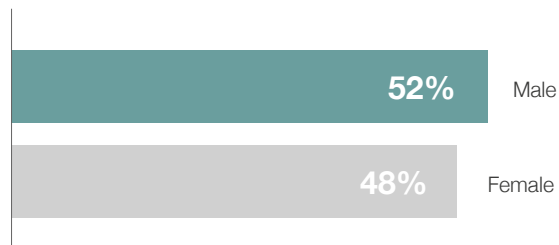
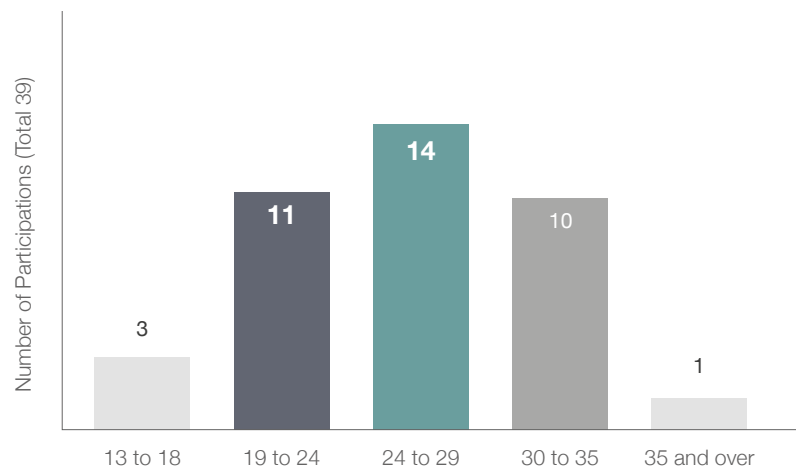


Chart 8. Age (Survey)



Thesis Survey

I am Industrial design student at Rochester Institute of Technology. I am working on reseach of emotional communication device. **Thank you for spending your time for survey ^^**

1. What is your age range?

☐ 13-18 ☐ 19-24 ☐ 24-29 ☐ 30-35 ☐ 35 and over

2. What is your gender? ☐ Male ☐ Female

4. Do you know your emotions?

☐ Yes ☐ No

4.If **YES**, how did you know?

☐ By Experience in the past ☐ By physical change ☐ By Communication with other ☐ ETC. _____

5.If **NO**, because _____

☐ Unfamiliar to express ☐ Too busy to think about emotion ☐ Let emotions flow

☐ Complicated (different emotions at the same time) ☐ ETC _____

6.Do you know emotions of others, such as friend , family or coworker, etc. ?

☐ Yes ☐ No

7.If **YES**, how did you know?

☐ By Facial expression ☐ By Situation or circumstance ☐ By Communication with them

☐ By Tone of voice ☐ ETC. _____

8.If **NO**, because _____

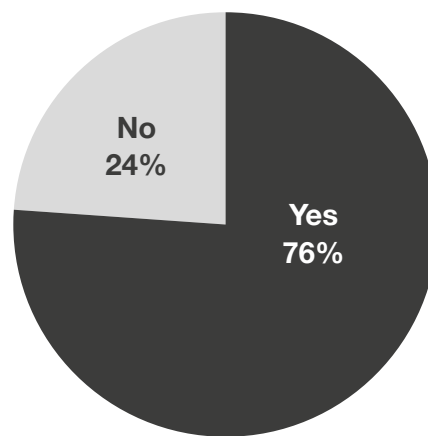
☐ They don't say ☐ They are Poker face ☐ They want to hide ☐ I don't care ☐ ETC _____

9.Express your emotions.

..... Thank you~

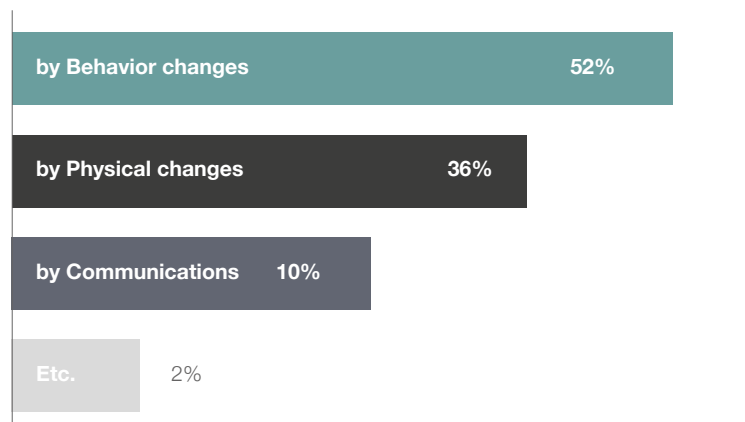
Originally, this paper-and-pencil survey was planned to figure out how people express their emotions on a small piece of paper with a writing tool. On the assumption that people present their emotions in short sentences or words, there were no limitations of time and way to do this. Also, respondents could choose from one of three different colors of felt pen provided to fill out this survey. To complete survey took about 5 to 10 minutes including time to select one color of pen.

Chart 9. Understanding one's emotions by oneself (Survey)



* Total 25 (aged 19-29)

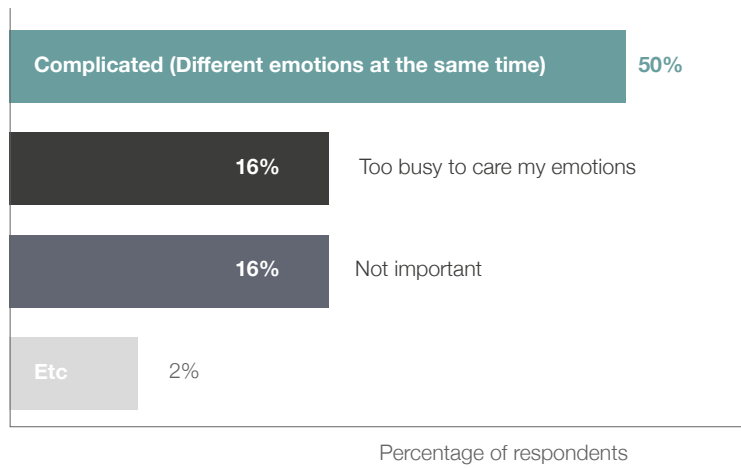
Chart 10. The way to recognize one's emotions (Survey)



Percentage of respondents

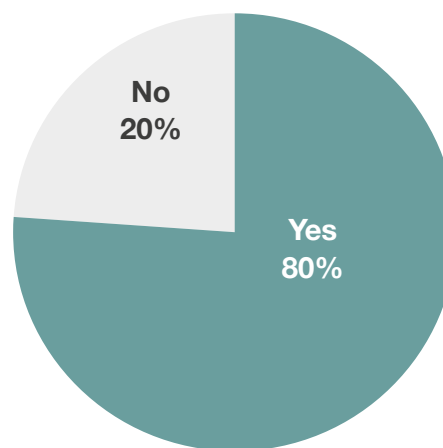
* Total 25 (aged 19-29)

Chart 11. The reason not to understand one's emotions (Survey)



The questions from number 3 to 5 on the survey were done to see general information that people have a proper understanding of their emotions. 76 % of them answered that they recognize their emotions. They notice their emotional experience through behavioral, physical, or perception changes.

Chart 12. Understanding emotions of others (Survey)



* Total 25 (aged 19-29)

Chart 13. The way to recognize emotions of others (Survey)

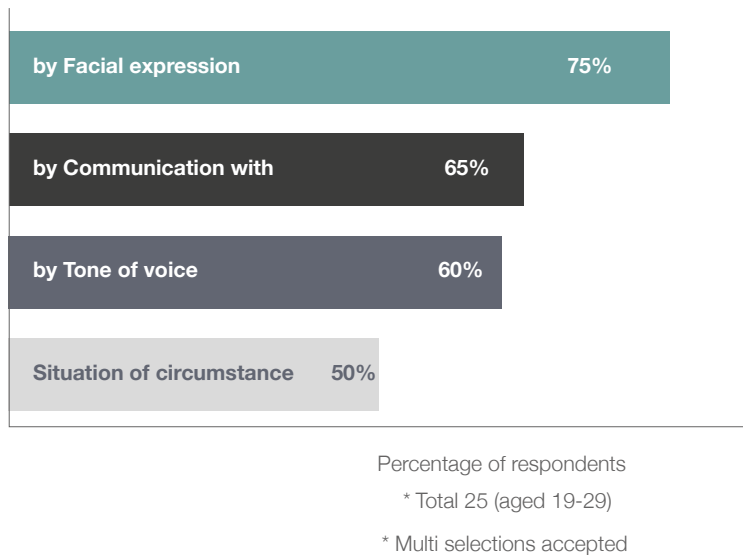
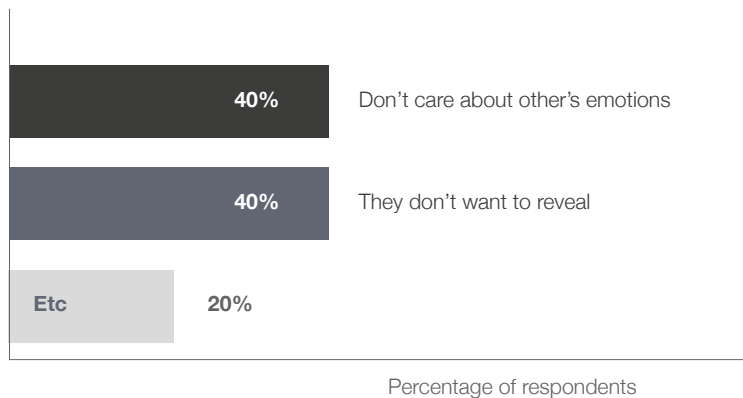
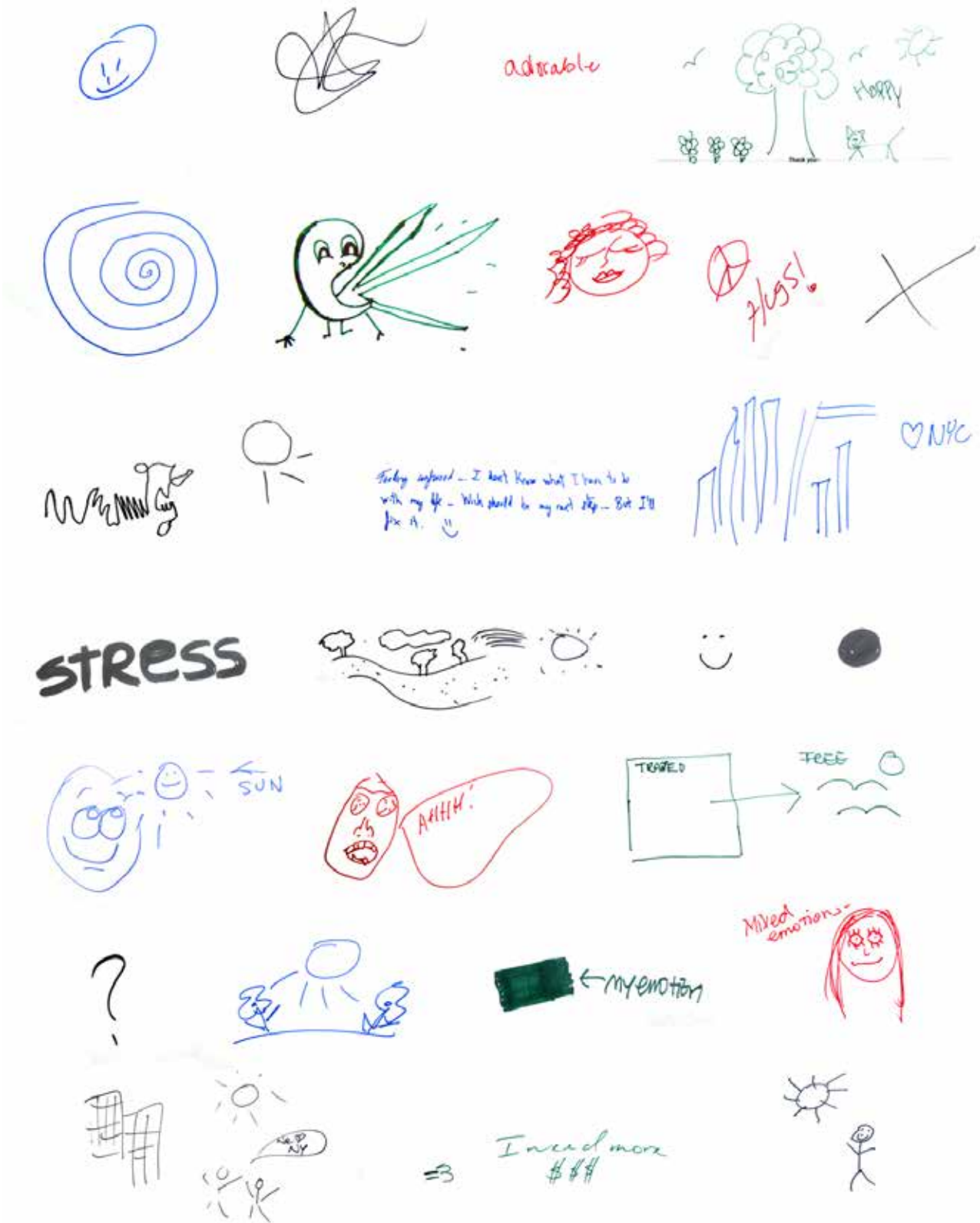


Chart 14. The reason not to understand emotions of others (Survey)



80% of respondents answered yes to the question number 6 that they know others' change of emotions. They realized these changes through others' facial or behavioral expression of emotions. 20% of participations could not anticipate others' emotional changes because they are not interested in the unrevealed or revealed others' emotional changes.

Figure 18. The results of expression of emotion by writing tool (survey)



The last question of this survey is express emotions without any instruction of how to display emotions — each respondent only has pen and survey sheet. The expectation I had that people will write down emotive words or phrases is different from actual results. Participation painted a simple and small picture in 5 minutes. There are many different types of drawings, such as portrait with an expressive face, unidentified abstract painting, or landscape painting (Figure 18). 44% of results are simple drawings, 40% are drawing and words, and 16% are words and phrases. 36% of drawings are landscape painting which may be not related to emotions (Figure 19).

Some participations want to change the color of pen. Since only some of them switch the color of pen, relationship with color and emotional expression is arduous to prove totally with this survey; to some extent, personal color preference may be relevant to the emotional state. These results from survey mean that drawing can consider as the immediate way to express emotions without cognitive process.

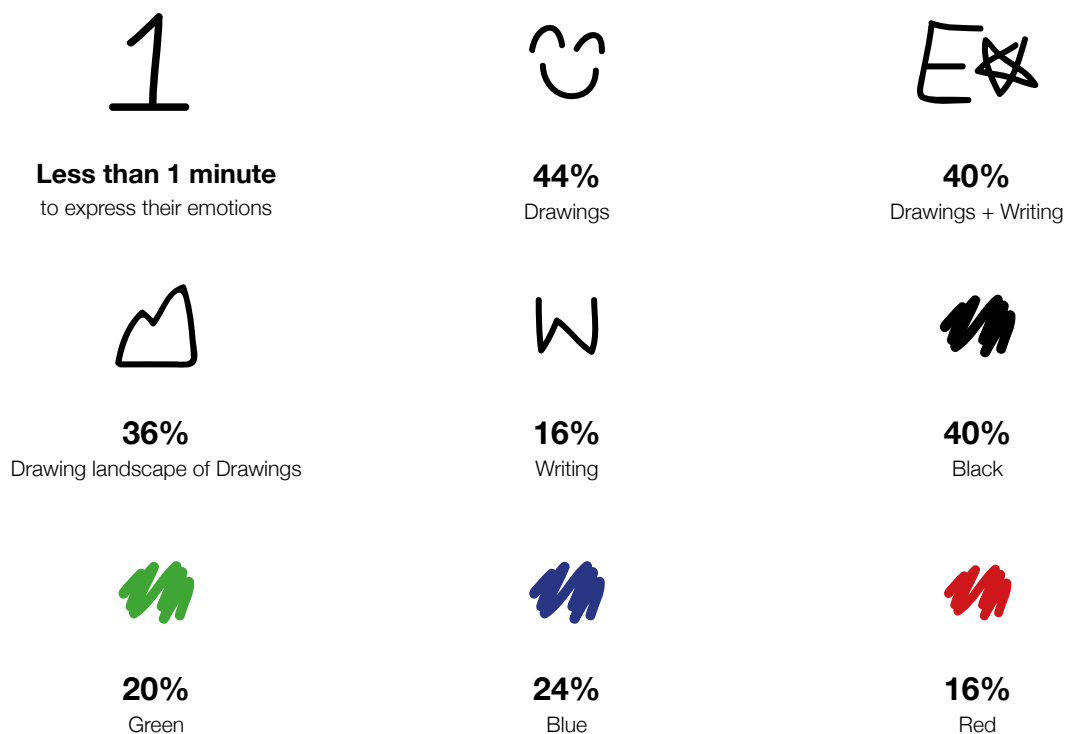


Figure 19. The Analysis of expression of emotion by writing tool (survey)

This chapter has described the methods used in investigation of target user and it has indicated several characteristics of target user group:

- a) student or worker aged 18 to 25,
- b) having an interpersonal relationship in community,
- c) being good at using electronic products and writing instruments,
- d) spending personal time for self-satisfaction and self-development.

The next chapter, therefore, moves on to discuss main objectives based on findings from previous and this chapters.

Chapter 04 : Objectives

Chapter 04

: Objectives

Objectives

The principal goal of this study is to propose a new product or service which helps people lead an emotionally healthier life through properly understanding and expressing their emotions in daily life.

Emotions influence not only physical and physiological changes, but also mental and behavioral changes. These changes impact the life and interpersonal relationships of an individual and, by extension, the community or society (Schater and Daniel, 2011). Thus, correct judgment on emotional experience and active management of emotions should be emphasized to improve emotional health, and the ability to manage and to verify both one's and others' emotions is defined as Emotional Intelligence (EI) (Mayer and Salovey, 1990). Mayer and Salovey (1990) addressed that people with higher EI were flexible and creative to think because they are proficient to perceive, use, understand, and manage emotions. Therefore, this study will explore to find the solutions to help people to discover the reasonable way to manage emotions by oneself.

Many researchers stated emotional changes derived from positive or negative emotions. Positive emotions are experienced when there are achievements or interesting things; in contrast, negative emotions occur when serious failure is experienced (Fox, 2008). Seligman and Csikszentmihalyi (2000) stated that positive aspects of life such as hope might be necessary for the "good life." However, the degree of response to stimulation from positive or negative emotions is different individually because of temperament and personality. The satisfaction and happiness of life depends on individual subjective experience (Andrew and Withey, 1976; Campbell, Converse and Rodgers, 1976; Cantril, 1965). Thus, this study will focus on conveying information of emotional states, instead of evaluating positive or negative emotions.

Keywords

This study proposes to design the emotional expression device to enhance the ability to manage emotions and the system to measure and show emotional state. With the results of research on emotion and target user, this study sets up three keywords for development and evaluation of design concepts.

The first keyword is easy visual interaction. The emotional state should be easy to recognize and even to identify emotional changes of the day. Also, this visual information should be simple to deliver to the user. The second keyword is private use in public. The target user spends most of their time having an interpersonal relationship in the community so they would have to hide or control their emotions. It is necessary that they can express their emotions privately without disturbance from others. The last keyword is usability and portability. Since emotions are caused by the various stimuli, the emotional expression device should be possible to use anytime and anywhere. To do so, this device should be portable and easy to use.

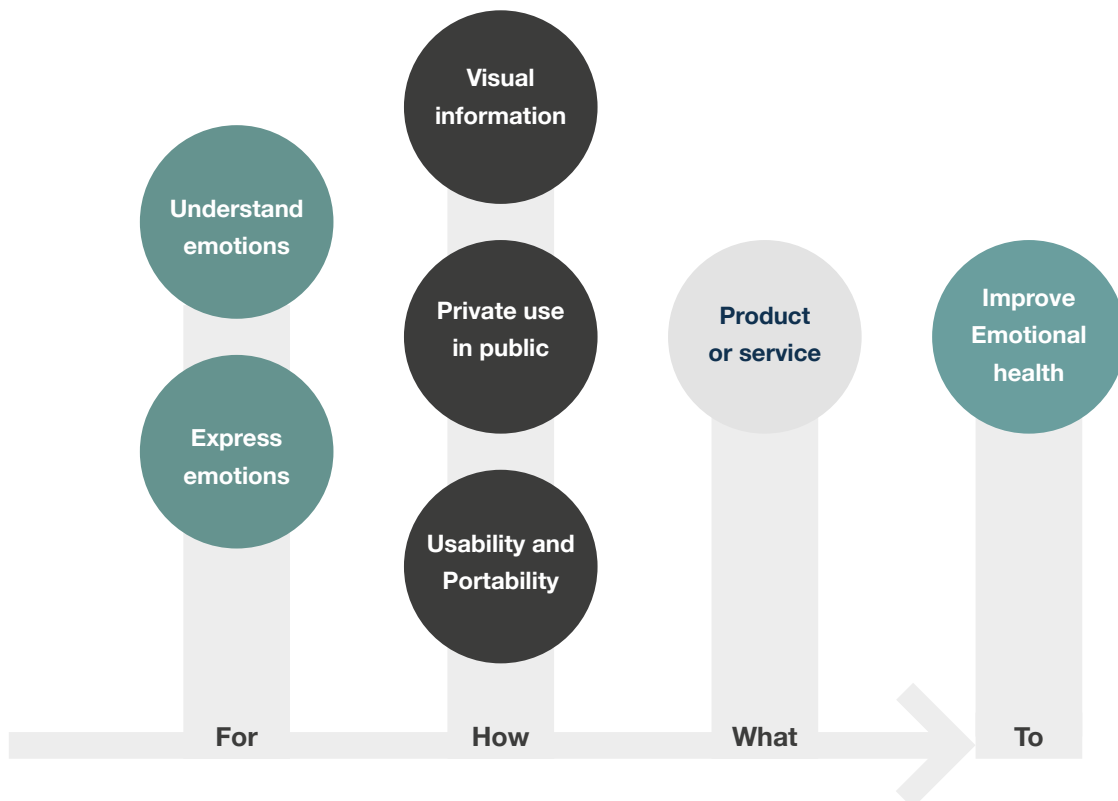


Figure 20. The Design concept development process

Chapter 05

: Concept development

Initial concept development

Concept 1. Real time

Concept 2. Behavioral self-reporting

Concept 3. Cognitive self-reporting

Evaluation

Chapter 05

: Concept development

This chapter explains the process of generating and expanding initial ideas from the design objective through 2D and 3D sketches. The design process in this study is different from the process of proposing the new design by solving the problem of an existing product or service. In the stage of concept development, it will focus on finding potential and creative solutions to an interaction between human and device.

Initial concept development

Early design concepts developed into three methods, based on conveying information about the user's emotional state. The first informs the user of emotional changes in real time. The second allows the user to collect information about their emotional state with simple actions that are irrelevant to emotional changes when one recognizes changes of emotional state. The last is a device that records cognitive expressions of emotion and measures emotional state while doing so. It collects and sends data to an application in which the user can check information after usage.

| | | |
|----------------------------------|---|---|
| Visual information | Show emotional states | Color, Pattern, or symbol |
| Private in public | Different type of expression Subjective, Spontaneous, Emotional regulation | Invisible Small action Ordinary behavior |
| Usability and portability | Available anytime anywhere, Frequent use | Hand-held, Small, light weight Simple reaction and feedback by vibration or blinking |

Table 5. The Design concept development process 2

Concept 1. Real time

Concept 1. Real time

This idea is a wearable device on the wrist. It has a thin and flexible display to exhibit the graphic patterns that show emotional change detected by sensors in real time. Different sizes, colors, and patterns present the intensity of emotional state. When the device detects a dramatic change of emotions, it will vibrate to alert the user to the information. Measured and recorded complete data of emotional changes can be ascertainable by the application on the computer. Even though this device collects and updates real-time data, it is inconvenient that the user needs to confirm and to interpret visual patterns by him or herself (Figure 21- 24).

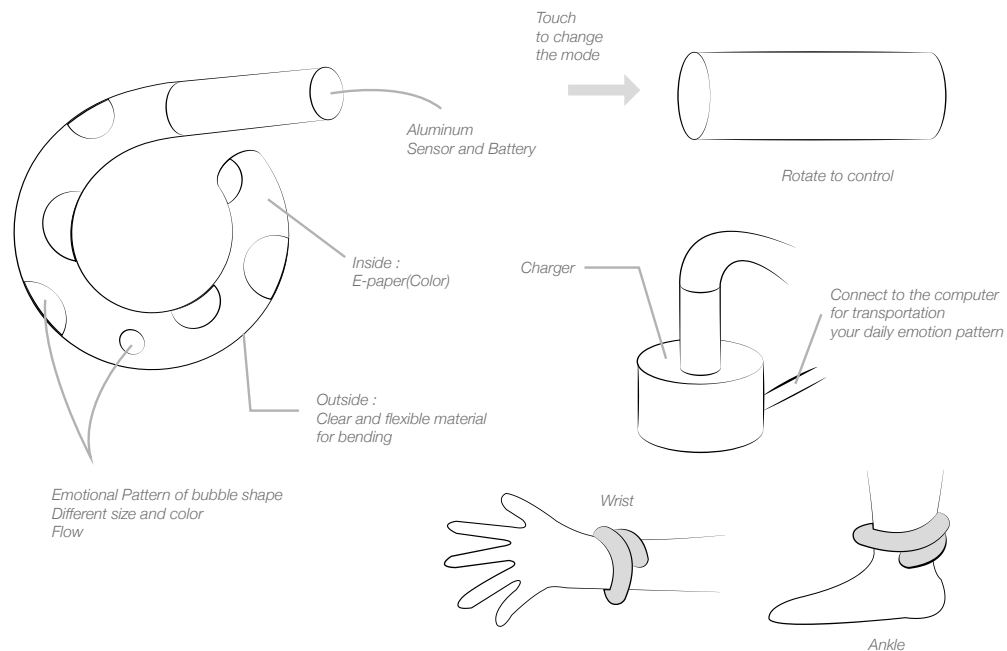


Figure 21. 2D concept sketch (Real time) 1

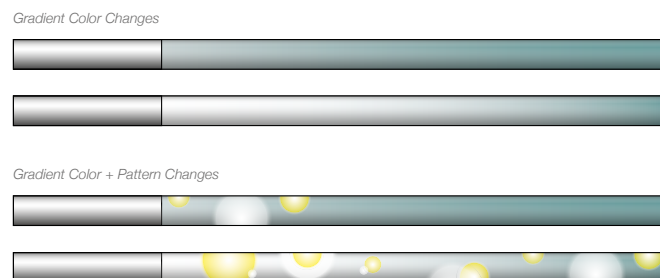


Figure 22. 2D concept sketch (Real time) 2

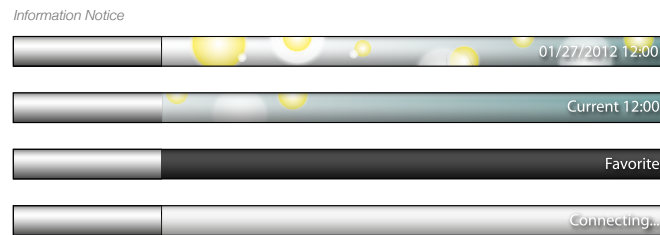


Figure 23. 2D concept sketch (Real time) 2-1



Figure 24. 3D concept sketches (Real time)

Concept 2. Behavioral self-reporting

This idea inspired by soft rubber toys is to measure emotional states with a simple action. The palm-sized device covered with soft materials enables one to express emotion through small physical movements such as squeezing, shaking, or stroking. When the user pushes or touches the top buttons for measuring an emotional state, the screen shows drop-shaped icons. Each icon shows measured emotional state by color with a time record (Figure 25). From this basic idea, explore with multiple shapes (Figure 26) to find better forms to use. This portable device is based on self-reporting when a user wants to record an emotional change, but it has a weak point in that users can express their emotions through a simple hand movement.

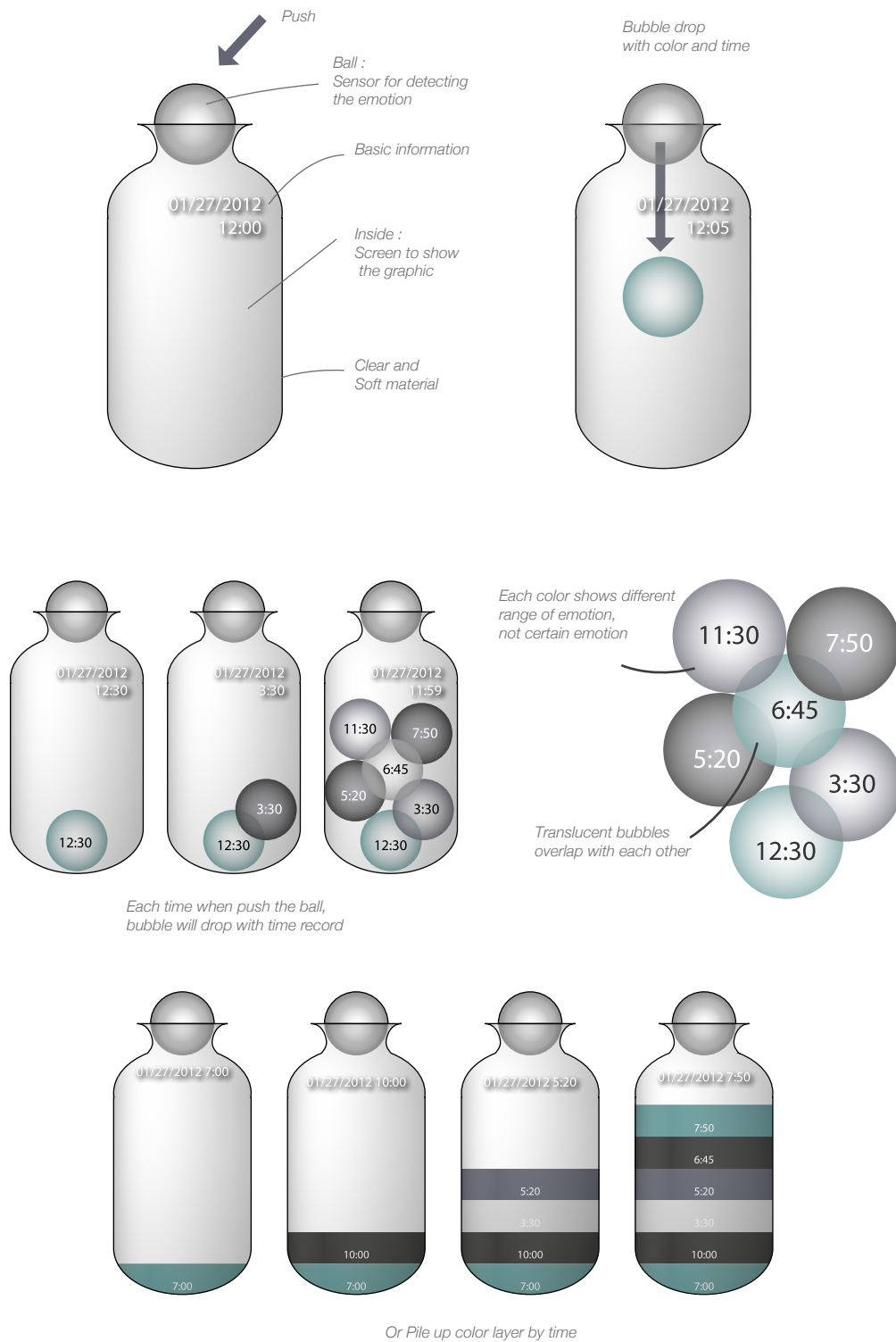


Figure 25. 2D concept sketch (Behavioral self-reporting)



Figure 26. 3D concept sketches (Behavioral self-reporting)

Concept 3. Cognitive` self-reporting

Concept 3. Cognitive self-reporting

This concept is focused on emotional expression and is different from the previous two concepts that are concentrated on the delivery information of emotional states. The pen-shaped design is intuitive so that users can know how to express their emotions easily. Also, this device measures emotional state during emotive writing or drawing without additional action. A writing or drawing will be saved in a mobile application, like a diary, and users can confirm their emotional state as well as changes later. Users can measure their emotions by tapping or holding this without writing or drawing (Figure 27 and 28).

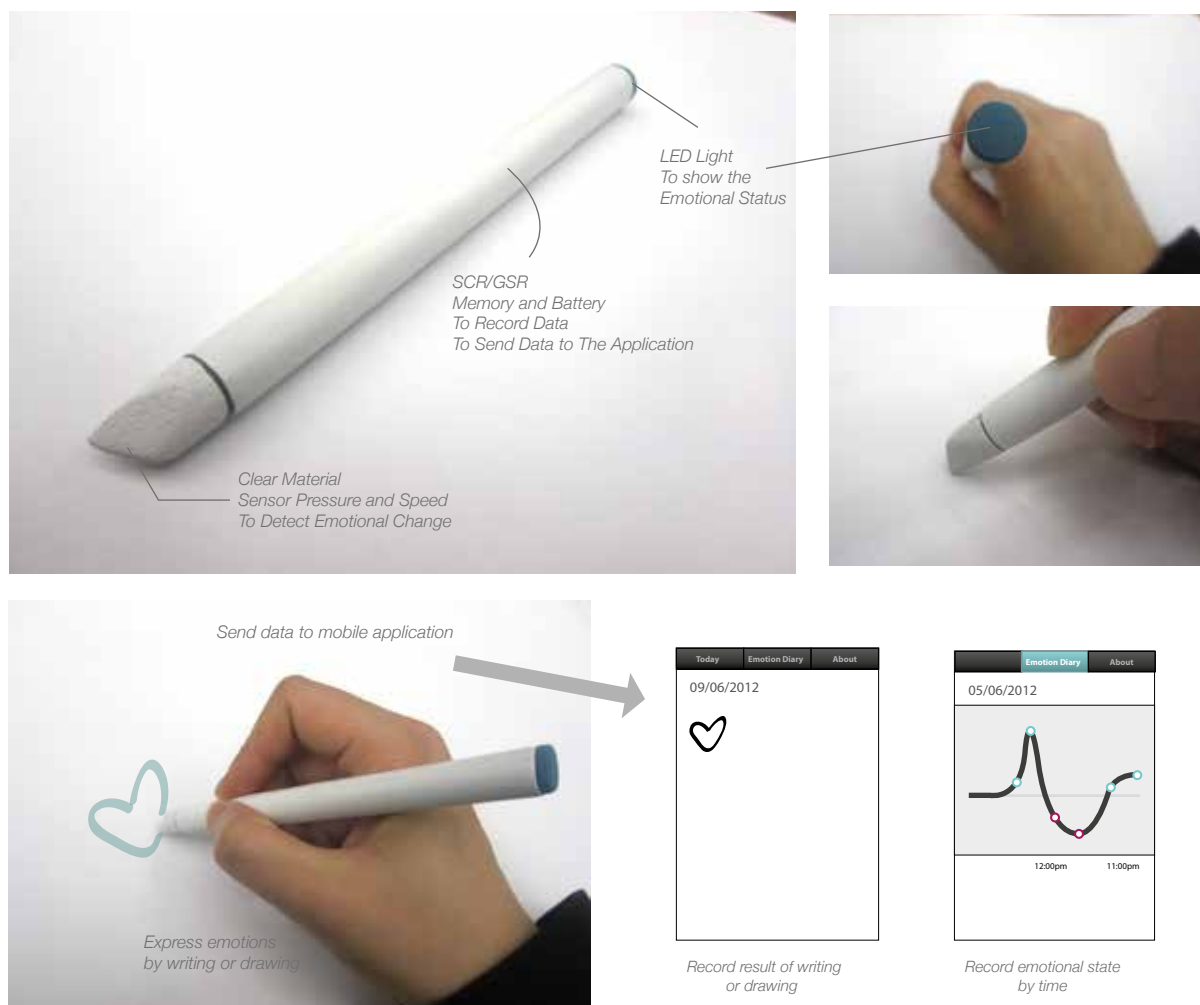


Figure 27. 3D concept sketch (Cognitive self-reporting) 1

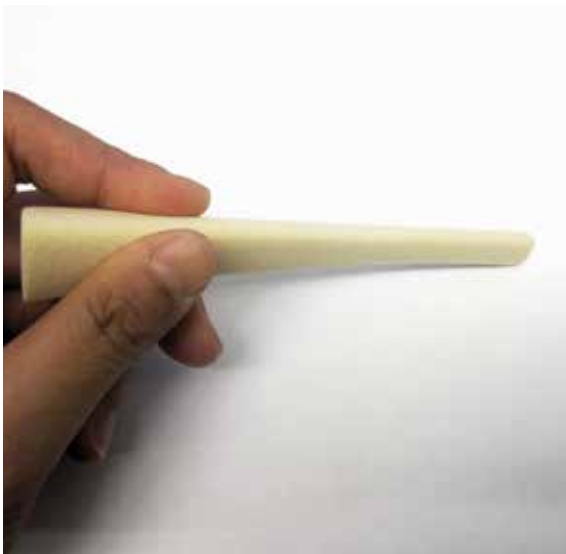


Figure 28. 3D concept sketches (Cognitive self-reporting) 2

Evaluation

The final design concept is adopted by evaluation with three subjects: easy visual interaction, private use in public, and usability and portability. Table 6 shows the pros and cons of each concept under the detail. Concept 3 is viewed as a suitable idea to develop as a final design because it provides an opportunity to express emotion privately in a public space through easy and familiar usage. Behavior to use a writing tool can be generally acceptable for use anywhere and anytime. Also, representing emotional state by a graph in a mobile application is available to check information for both emotional state and daily changes efficiently. Convenience and intuitiveness in the use of Concept 3 are appropriate reasons for selecting it as a final design concept. There is abundant room for further progress in determining the final design, so undertaking more research is necessary. The following chapter will research the theoretical and technical approaches to measuring emotions and self-reporting.

Table 6. Evaluation of three concepts

| | Visual information | Private in public | Usability and portability |
|---|--|--|---|
| Concept 1. Real time | <ul style="list-style-type: none"> - Check the data immediately - Possible to lose or miss information | <ul style="list-style-type: none"> - Everyone can see - Not available emotional expression by this | <ul style="list-style-type: none"> - Wearable, - Available anytime and anywhere |
| Concept 2. Behavior self-reporting | <ul style="list-style-type: none"> - Check the data immediately - Simple information only | <ul style="list-style-type: none"> - Someone can see - Conscious to operate - Not related expression with emotional state | <ul style="list-style-type: none"> - Available anytime and anywhere - Tangible |
| Concept 3. Cognitive self-reporting | <ul style="list-style-type: none"> - Check the data by other device - Available detail information | <ul style="list-style-type: none"> - No one can see - Conscious to use - Possible emotional expression by writing | <ul style="list-style-type: none"> - Handy - Available anytime and anywhere |
| Selected as final concept : Wide general acceptance in use, available detail information, Possible subjective emotional expression | | | |



Chapter 06

: **Concept research**

Measurement of emotions

Written emotional expression

Technical research

- GRS

- Invisible

Chapter 06

: Concept research

As shown in the previous chapter, this study determined Concept 3 as the final design, and the following chapter showed additional research to reinforce its reliability and feasibility.

Measurement of emotions

Whether the emotions can be measured is one of the significant segment to support this study. As mentioned in Chapter 2, emotions, feelings, moods, and affect each have a definition and distinction (Davidson, 2003). Hence, this study should determine what of those to be measured and used for the final design. In particular, Fox (2008) argued that both measures of emotions and mood states are available. Beedie (2005) explained the distinctions between emotion and mood (Table 7). According to his research, emotion is caused by a specific event that an individual recognizes and involves clear behavioral and expressive consequences.

Table 7. A summary of the distinction between emotions and moods

| Criterion | Emotion | Mood |
|---------------------|------------------------------------|-----------------------------|
| Anatomy | Related to the heart | Related to the mind |
| Awareness of causes | Individual is aware | Individual may not be aware |
| Cause | Specific event | Cause less well defined |
| Clarity | Clear | Nebulous |
| Consequences | Behavioural and expressive | Cognitive |
| Control | Uncontrollable | Controllable |
| Display | Displayed | Not displayed |
| Duration | Brief | Enduring |
| Experience | Felt | Thought |
| Intensity | High | Low |
| Intentionality | Related to specific object | Objectless |
| Physiology | Distinct responses | No distinct responses |
| Stability | Fleeting and volatile | Stable |
| Timing | Rise and dissipates rapidly | Rise and dissipates slowly |

Source : adapted from Beedie et al. (2005) and Fox (2008)

Its intensity is high, and it lasts for a short time. On the other hand, mood is imprecise because it is difficult to define cause well. Given that its intensity is low and stable for a long time, it involves cognitive consequence without specific physiological reactions. As a result, this study will use the method of measuring emotion for the final design.

Given that emotion entails complex changes of physiology, behavior, and cognition, many scientists argue that emotion cannot be measured completely. Frijda (1986) postulated that the tendency of action and physiological correlation are the decisive elements for measuring human emotions. Although many different methods of measuring emotions exist, this study will discuss more how to measure physiological and behavioral changes.

Fox (2008) organized common techniques to measure emotions by physiological responses (Table 8). He also stated that physiological and emotional changes are controlled by the Autonomic Nervous System (ANS), which sends various signals throughout the human body. For example, when a person feels excited, adrenaline is produced and secreted, and the heart rate is accelerated. Among the techniques described in Table 8, this study chooses the Galvanic Skin Response (GSR), which is also called the Skin Conductance Response (SCR), in order to utilize the final design, and will discuss more details in the technical research section.

Since the final design is based on the action of writing or drawing, a correlation between behavioral and emotional changes will be used to measure the emotional state. When a person is very upset, he or she behaves a certain way (e.g., kicking or yelling). Likewise, when people write or draw something, their tendency to act will be variable, such as fast or slow, with high pressure or low pressure.

Table 8. Common techniques for measuring physiological responses in emotion science

| Technique | Description |
|---------------------------------------|--|
| Skin conductance response(SCR) | By applying a small electric current across the fingers the electrical resistance of the skin can be measured. Even very small differences in amount of sweat can be detected. These changes are usually measured in unit called micro Siemens. The SCR is sometimes called the galvanic skin response (GSR) and is a very sensitive measure of physiological arousal. |
| Heart rate (HR) | The number of heart beats that occur per minute(bmp) can be measured by a simple transducer which convert the movement produced by the pulse into electrical energy. Changes in HR provide a good index of changes. |
| Blood pressure (BP) | Systolic blood pressure (SBP) is the pressure in the arteries when blood has been pumped out of the heart, whereas diastolic blood pressure (DBP) is the lower pressure when blood is being drawn back into the heart. BP is measured in millimeters of mercury(mmHg) and normal BP is expressed as SBP over DBP. |
| Cortisol level | The steroid hormone cortisol can be measured in the blood, urine or saliva and is a good indicator of ANS arousal. |
| Electromyography (EMP) | Small electrodes can be placed on the skin (usually over the muscles beneath the eyes) and the level of muscle tension and activity can be measured. The startle reflex is measured by EMG and is the sudden another a good measure of arousal. |
| Respiration rate | Changes in respiration rate can be measured in terms of breaths per minute and also provides a good measure of physiological arousal. |

Source : adapted from Fox (2008)

Written emotional expression

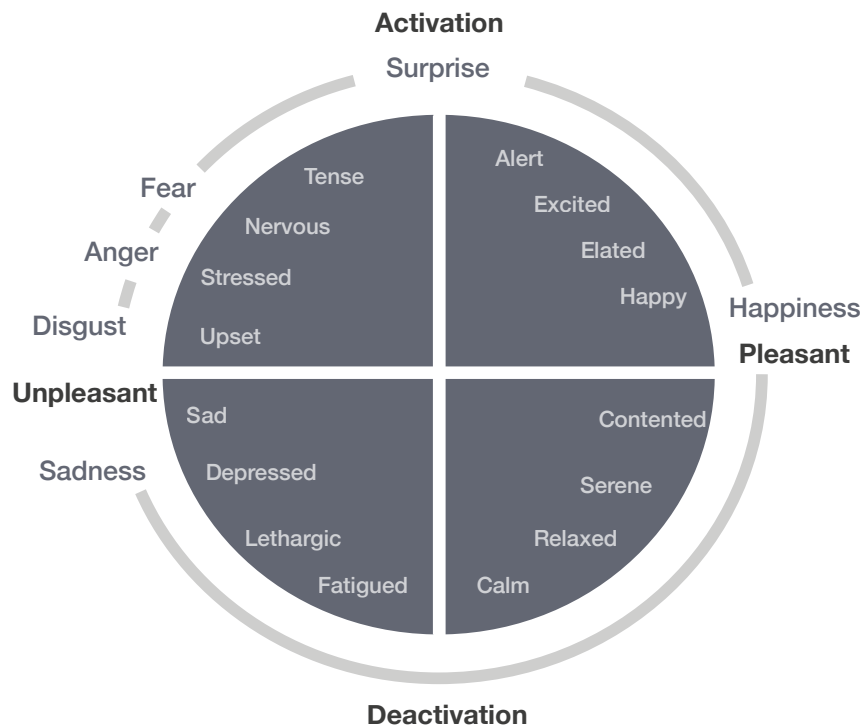
Proving the effect of conscious emotional expressions by writing or drawing is another important factor in this study. Although many researchers tried to prove the effectiveness of emotive writing, they could not show clear results because it is hard to monitor a large number of participants during a long period of time. However, Smyth (1998), in his meta-analysis on written discourse, found that writing about emotional experiences can reduce distress.

There are several interesting results from studies of written emotional expression. First is that self-reporting is suggested. Although it is painful to write about one's emotions every day, writing about an unpleasant experience has an impact on one's distress or on one's mood, if it is self-reported (Pennebaker, 1997). The second intriguing result is that the tendency for participants to behave aggressively is reduced during writing. Lastly, the most interesting fact is that writing about emotion is effective without social feedback. Pennebaker (1997) introduced Czajka's studies (1987) that used a 'magic pad' on which the writing disappeared when participants lifted the plastic cover. In this experiment, participants using the magic pad had more effective results. These interesting findings from research will support the concept of final design.

Two-dimensional model of emotion

To show a visualized emotional state, this study chose Russell's (1985) circumflex structure of emotion concepts, based on dimensions of affect (Russell, 1985). As figure 29 shows, this model has two axes: pleasure to displeasure and activation to deactivation. This model is suited to display emotional states measured by sensors to the application. In this study, the data from GSR will be used to determine the horizontal position. The collected data from the pressure sensor and accelerometer, which detect the speed and force during writing or drawing, will be used to assign the vertical position.

Figure 29. Structure of two dimensional model of emotion



Source: adapted form Russell's model (1985)



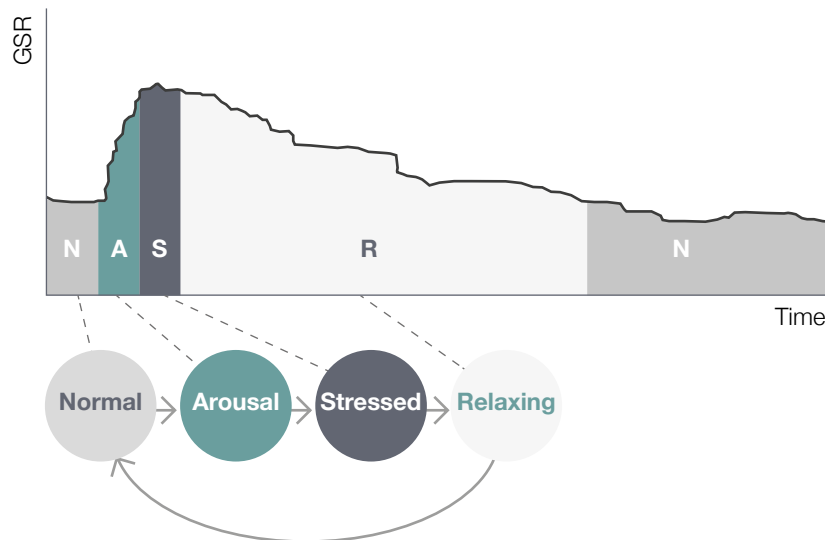
Figure 30. Plan to apply two dimensional model of emotion to this study

Technical research

Galvanic skin Conductor(GSR)

GSR is one of the most common techniques that measure emotional states by detecting the changes in the sympathetic nervous system (Edelberg, 1977). When aroused by stimuli, the sympathetic nervous system responds to heart rate changes, sweat production, and other physiological reactions (Bakker, Pechenizkiy, and Sidorova, 2011). GSR detects micro-pulses of sweat on the finger and changes the signal by time (Richardson, 2011). There are some examples of how the signal is changed. Chart 15 shows the changes of GSR data and how it is mapped in the graph. Although the GSR data may not be accurate because other physiological changes can affect skin conductance, it is a good method to measure the emotional state during writing.

Chart 15. An example of acute stress pattern observed from GSR data and how it can be mapped to the symbolic (time-stamped) representation of person's stress.



Source: adapted from Bakker, Pechenizkiy, and Sidorova, (2011)

Invisible

The toughest problem in this study is to realize the invisible marking of the pen. During research to find the answer, two different ways are found. First is the experiment with disappearing ink. This experiment uses Thymolphthalein, 95% Ethanol, Sodium hydroxide, and distilled water and a simple knowledge of chemistry. When these elements are combined, a blue solution is created. When the blue ink is exposed to air, especially to carbon dioxide, it changes to water. After a certain time, the blue color is seen to disappear. However, it is not feasible to apply this to the final design. The second is the electronic pen, Wacom's Inkling. This electronic pen enables one to capture writing or drawing on paper and digitalize it. It is enabled with ultrasonic and infrared technologies. Although it is very useful to expand the idea, it is hard to study and apply to the final design right now. While looking for material to solve this problem, suddenly the optical mouse came into sight. As commonly known, it detects movement by optical sensors which process information through reflected light. It doesn't leave a trace after movement. Therefore, this study will apply this technique to the final design.

Chapter 07

: **Design and implementation**

The study of size and form

- Experiment to determine the size and form

Material and structure

Making process

Final design model

Technological implementation

Mobile application design



Chapter 07

: Design and implementation

This chapter describes and discusses the design processes and approaches used in the final design, divided into four main sections, each of which presents the results relating to the main issues addressed in this paper. The first section is the design process of emotional expression device design and the second section shows and reviews the process of implementation to demonstrate the trial version of the prototype. The third part moves on to illustrate the design process of mobile application design. The last section explains the process of user interaction. Overall, this chapter highlights the reason for the decision of final design by different experiments.

The study of size and form

Before proceeding to develop the final design of the emotional expression device, PEN+, it will be necessary to understand the writing instrument. A writing instrument is an object to write and to draw something for leaving on record. It has developed according to which surface will be used and with what kinds of ink will be used. The reed stylus is known as the first writing tool from around 4000 B.C. and was used for inscribing Cuneiform, which is the earliest writing system of Sumerians, on a soft clay tablet. The quill pen, which is made with a feather, was used by dipping ink and lasted longer in history. After this, the fountain pen was invented and functioned in a similar way as the quill pen by fill a hollow cylinder with ink. The next invention in the history of writing tools is the pencil, which is made of a wooden stick and graphite.

The ball-point pen, with a rotating ball placed at the tip, was invented in the early 20th century. These days, there are many different types of writing tools designed for ergonomics in the market. Also, the electronic pen, which records writing or drawings using a different system by connecting with the computer has emerged.

The most important factors in the progress of the development of writing instruments in history were the development of writing surface from clay to paper and ink from water-based to oil-based. The aim of development is to keep records longer. Another important point of this tool is that its size is manageable to use by hand. By considering these interesting features, this section discusses the size of the form of final design of emotional expression devices through human factors and convenience to use by hand.

To determine the appropriate size of the final design, the length and width of common stationaries are measured. The length of most of them is from 5 inches to 7 inches, and the width is from 0.25 inches to 0.5 inches (Figure 30).



Figure 30. Length and width of writing tools

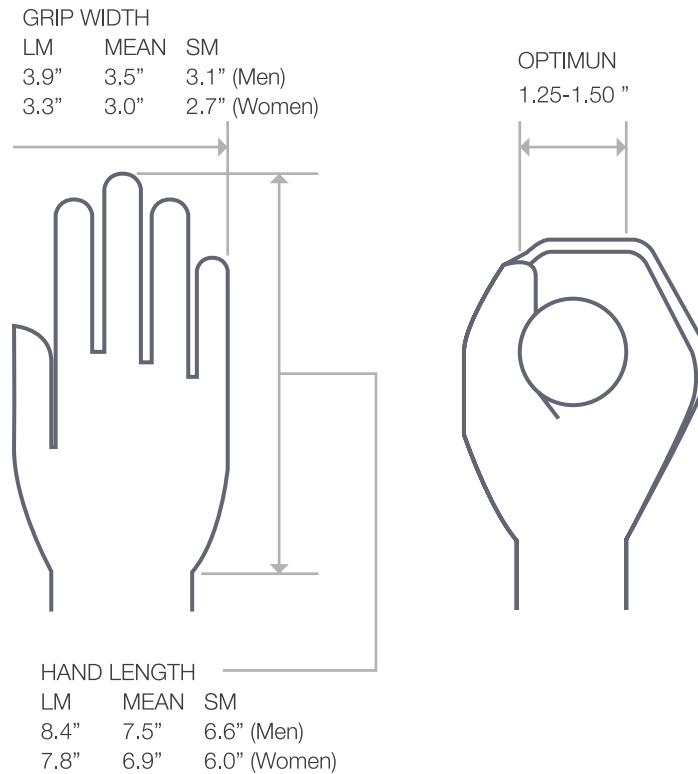


Figure 31. Human factors in writing tools

Source: adapted from Henry Dreyfuss associate, 1993,

The other method to define the final size is by studying human factors. According to Dreyfuss (1993), the average palm size is 7.5 inches for men and 6.9 inches for women. The optimum size is from 1.25 to 1.5 inches when people wrap something entirely (Figure 31). Thus, this study decided that the proper size range of emotional expression devices is between 5 and 6 inches long and 0.25 and 0.625 inches wide, and for the charger, a width of 1.25 to 2.7 inches.

Experiment to determine the size and form

With these results, this study plays fascinating experiments. As shown in the picture, I made the models using different shapes and widths and wrapped them in white paper. After painting on the palm, I used each model by holding it and writing with it. The area of stamped paint on each paper is different depending on the shape of each model. The wider models were stained with more

paint on the paper; however, it was uncomfortable to use wider models to write. Square- and triangle-shaped models were comfortable to write with, but they were uncomfortable to hold. The research and experiments aimed to find shapes and sizes suitable for collecting data from GSR sensors efficiently. Therefore, the 0.5 inch, round-shaped model was determined as the final design.



Figure 32. Experiment to determine the size and form 1



Figure 33. Experiment to determine the size and form 2

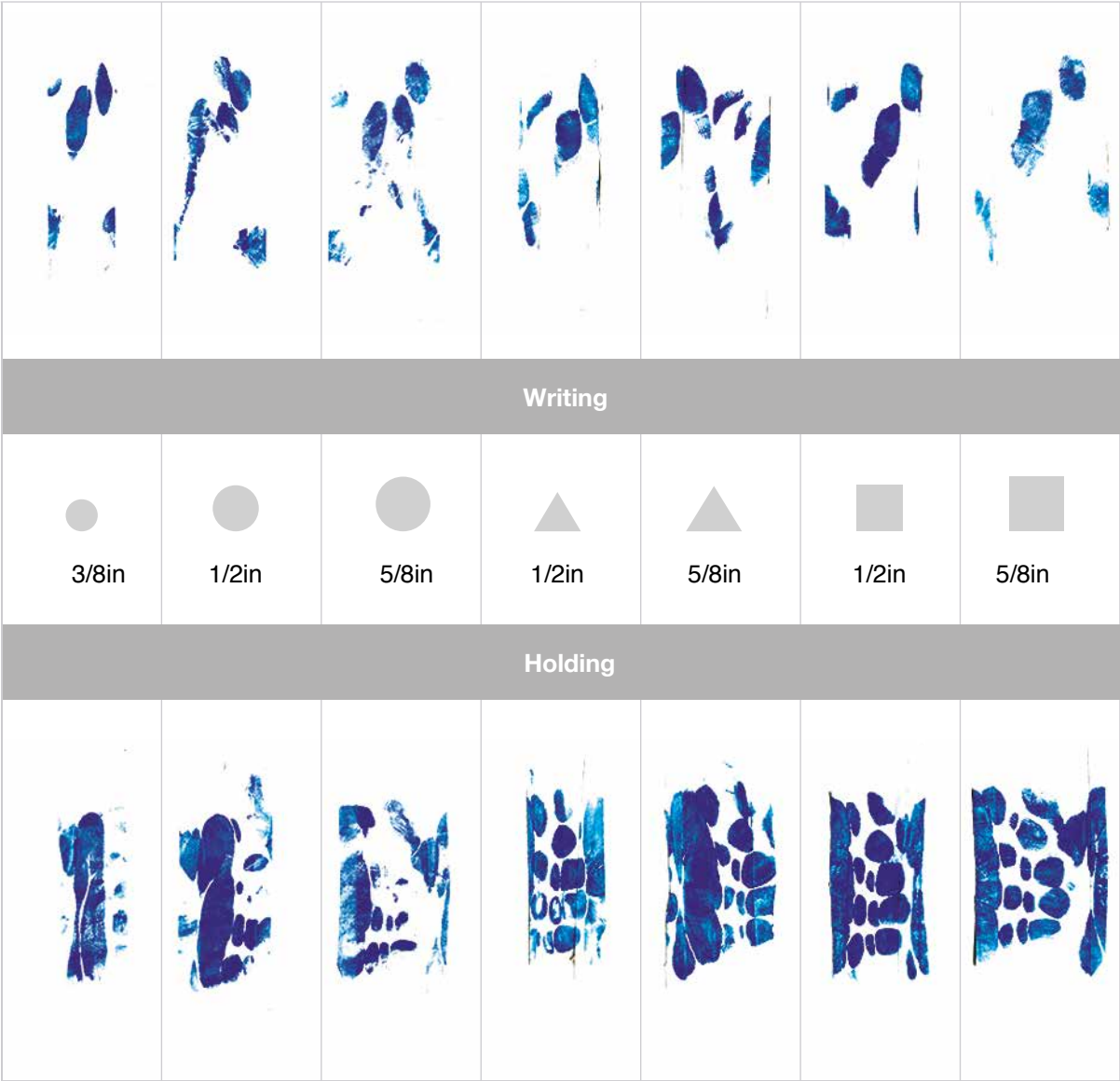


Figure 34. Experiment to determine the size and form 3



Figure 35. Experiment to determine the size and form 4

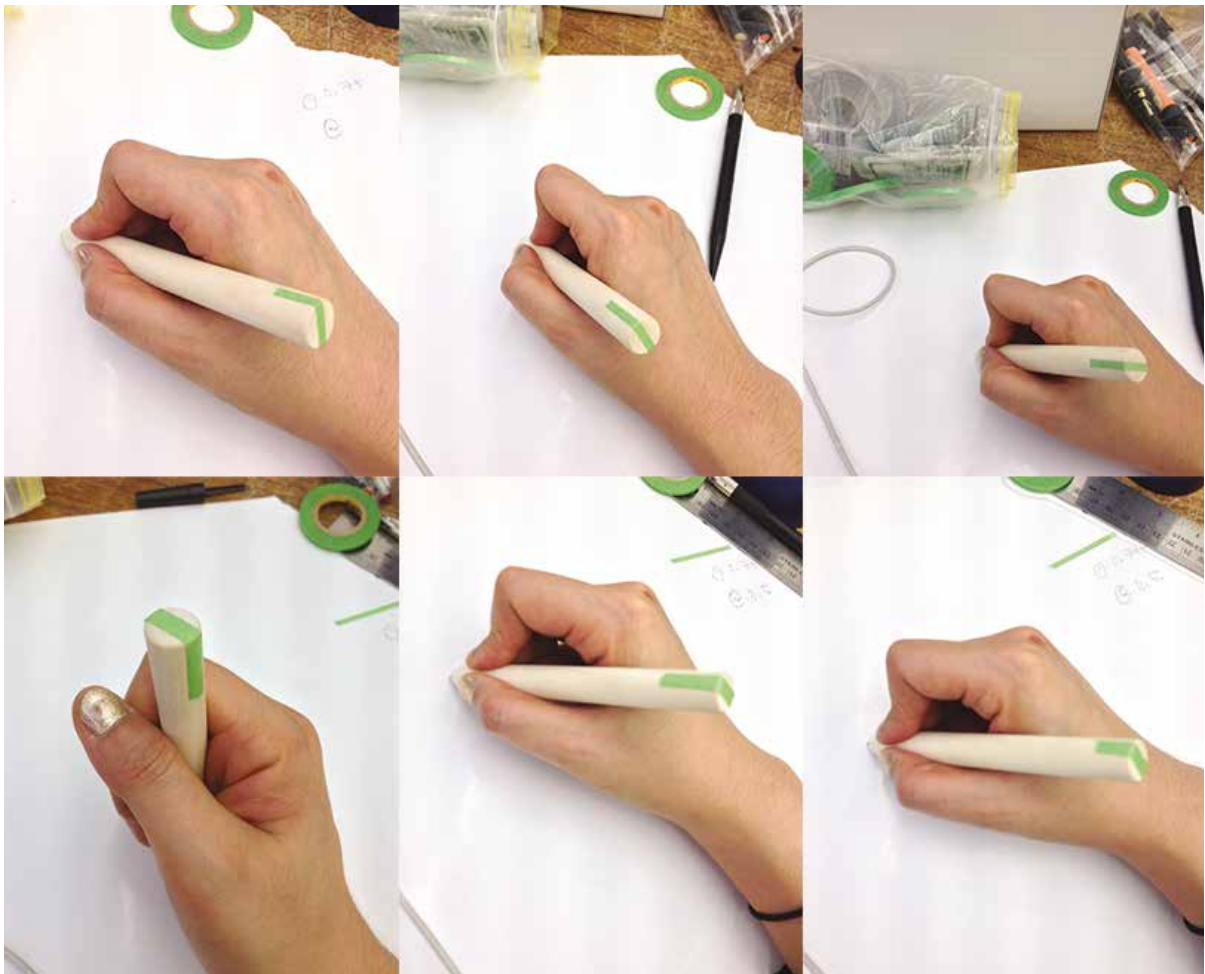
Figure 36. Experiment to determine the size and form 5



Experiment to determine others

Figure 37 shows the process of identifying an appropriate location of the indicator with the LED light. This indicator will blink as a warning when emotional changes are extreme while expressing emotions with the device. The indicator should be located in sight because glitter should be recognized immediately. Also, the charger, inspired by the shape of a positive sign, has two grooves on its top and bottom, which are used as a holder for the emotional expression device, as well as a smartphone cradle.

Figure 37. Experiment to determine the position of indicator



Material and structure

As studied in the previous chapter, the choice of conducting material to utilize for the electronic sensors in the final design is important. Aluminum is one of the most conductive materials and is the most suitable material to use on GRS. Aluminum has high resistance and does not pass low frequencies, so GSR can collect data effectively. Also, aluminum is a suitable material to make a mock-up because it is easy to get in the market and to process with metalworking. Aluminum is a soft and lightweight material. These features can support the portability and usability of the final design. People can carry and use the emotional expression device and charger without burden because of its lightness.

This study uses clear acrylic plastic for soft and smooth usability when the user writes or draws something with the device. Using a clear material also supports the function of the indicator. It allows blinking lights from the LED inside of the device to pass through so the user can confirm the warning.

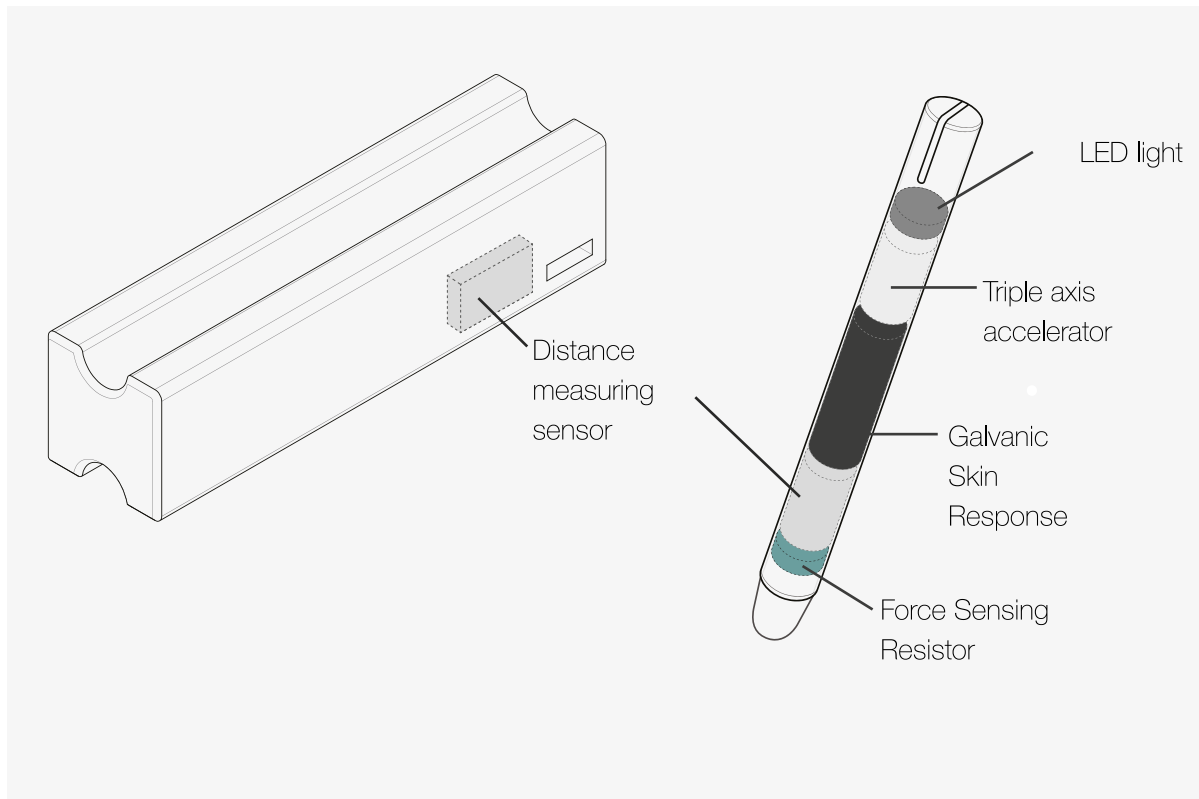


Figure 38. Overall structure of the final design

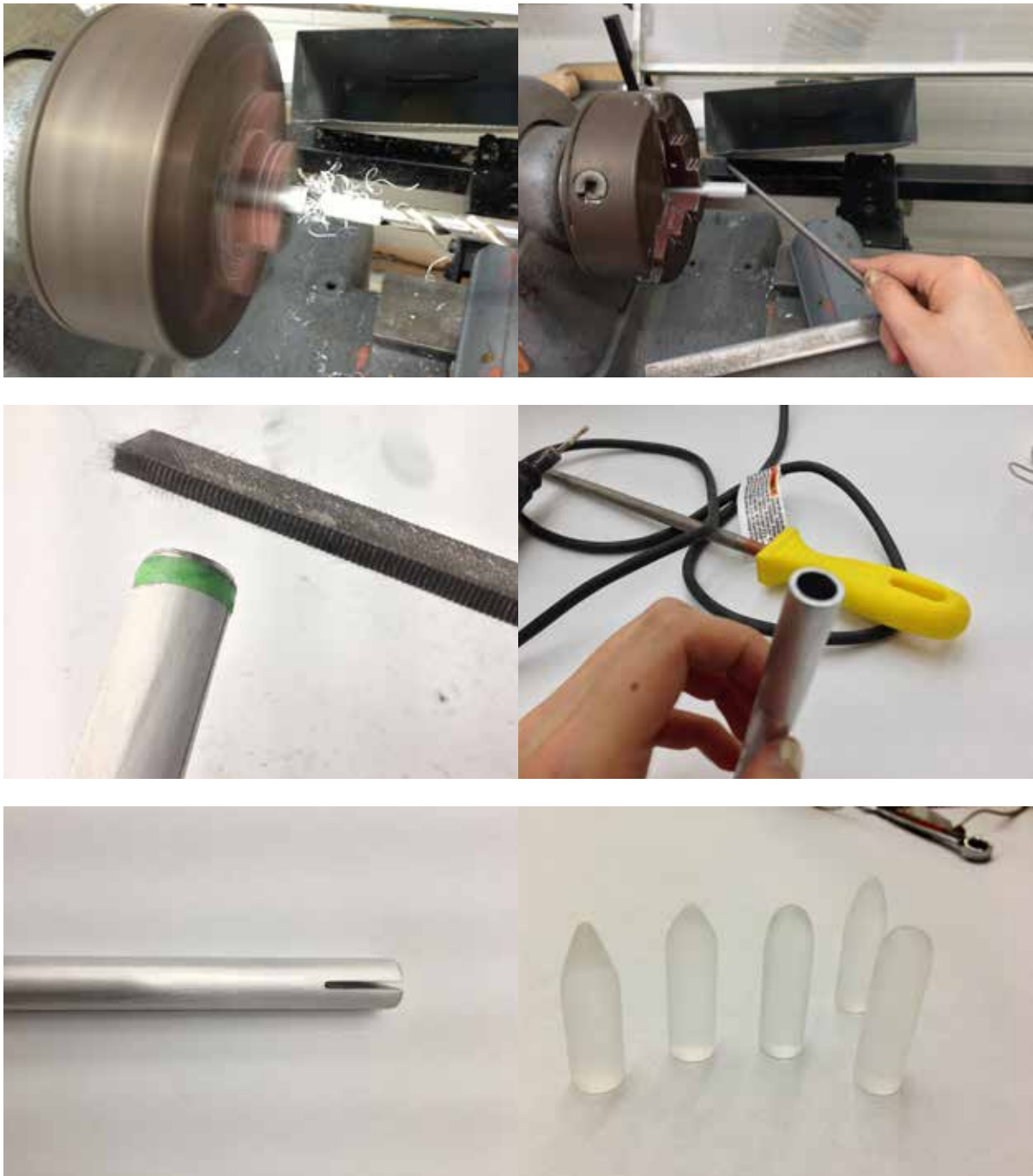
Several sensors and pieces of electrical equipment—the force-sensing resistor, GSR, triple axis accelerator, LED lights, and distance-measuring sensor—are located inside of the emotional expression device. This distance-measuring sensor is also paired with the sensor inside the charger. This sensor measures the distance between the device and the charger to record the invisible writing or drawing such as that from the optical mouse. As shown in Figure 38, the positions of all the sensor's electrical parts are random and can be changed to improve the effectiveness in the perspective of electronic engineering.

Making Process

Figure 39. Process in making the charger



Figure 40. Process in making the emotional expression device



The final design model

Figure 41. The final design model



Overall technological process of the final design

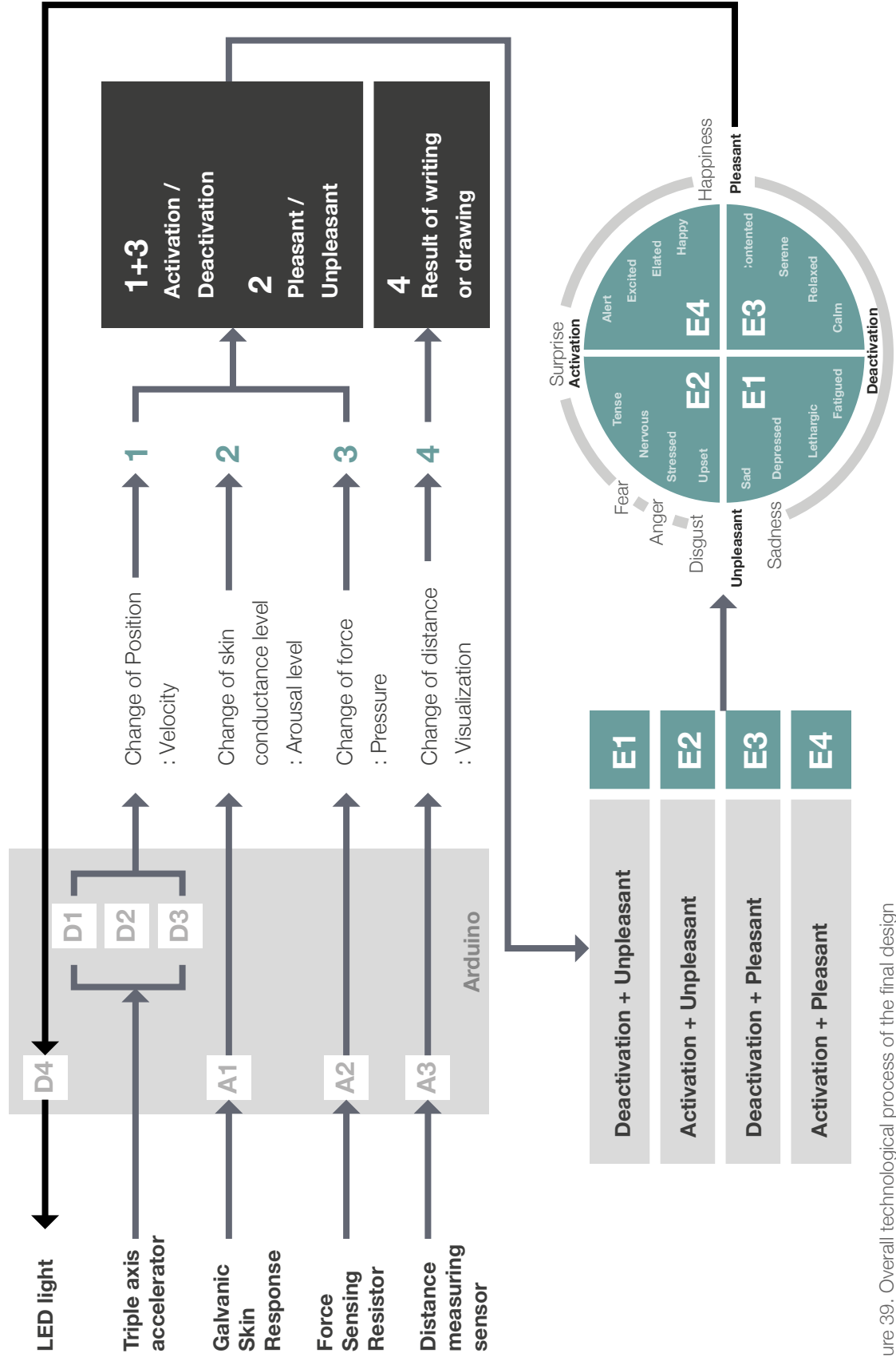


Figure 39. Overall technological process of the final design

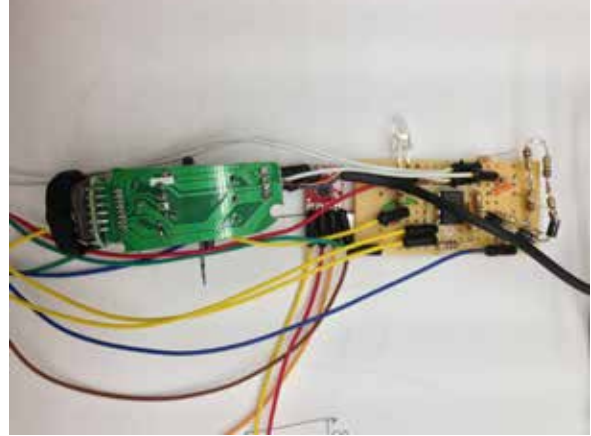
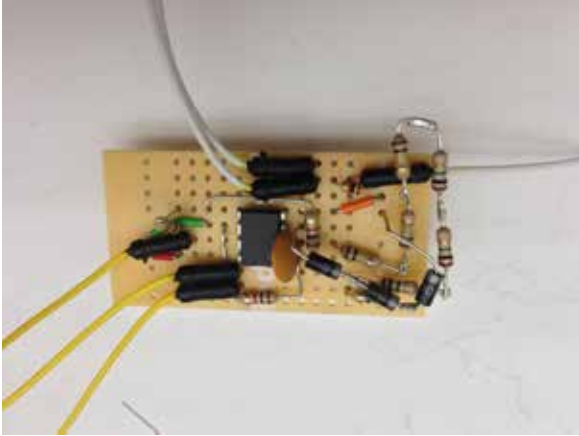
Technological implementation

Table 9 shows that different sensors and electronic parts were used in the experiment for the final design. Resistance was connected to each component for proper electricity flow. All parts were soldered to the small breadboard connect to Arduino UNO, which is the board for easy installing electronics, and coded with Arduino Sketch. Since Optical Mouse was situated in front of the device to experiment with invisible writing or drawing, the Force-sensitive resistor was located at the top, unlike in Figure 38. After that process, this model installed sensors that were connected to the computer to check electricity flow, and it operated. Although it operated, the problem was the linkage between the program and sensors. Figure.43 display the result of the test programs that used Arduino Sketch and Microsoft Visual Studio 2012. The hypothesis of the technical implementation was that the collected data from the sensors gather to the chip, and the chip sends data to the mobile application by Wi-Fi or Bluetooth. Unfortunately, the program did not work correctly. This limitation requires further research and experimentation to solve the problems.

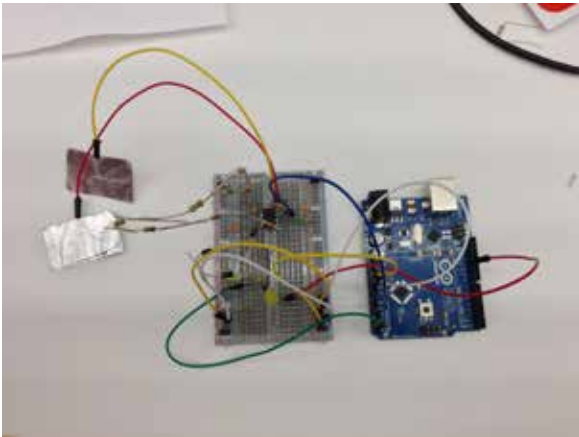
Table 9. The materials and programs of technological implementation

| Materials |
|--|
| Arduino UNO Capacitor Ceramic 0.1 μ F Op- Amp(Thru-Hole) LM358 Force Sensitive Resistor 0.5.” Triple Axis Accelerometer ADXL362 Silicon Diode IN4001 LED light 10k ohm resistor 100k ohm resistor 1 Mega ohm resistor Optical mouse |
| Program |
| Arduino Sketch Microsoft Visual studio 2010 |

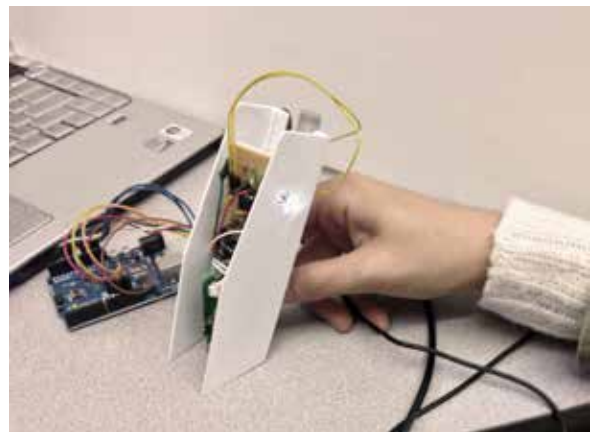
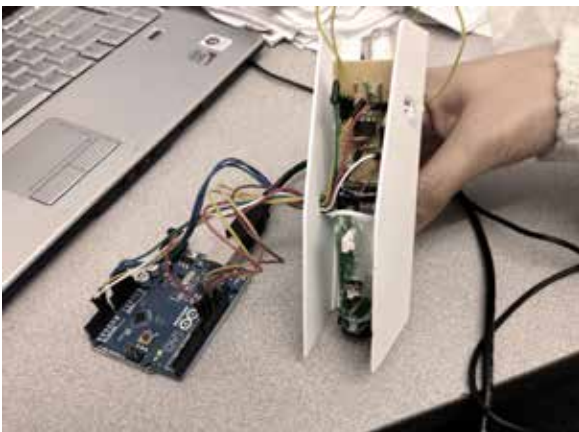
Figure 42. The technological implementation in making process



Soldering components and optical mouse



Testing GSR and force sensor

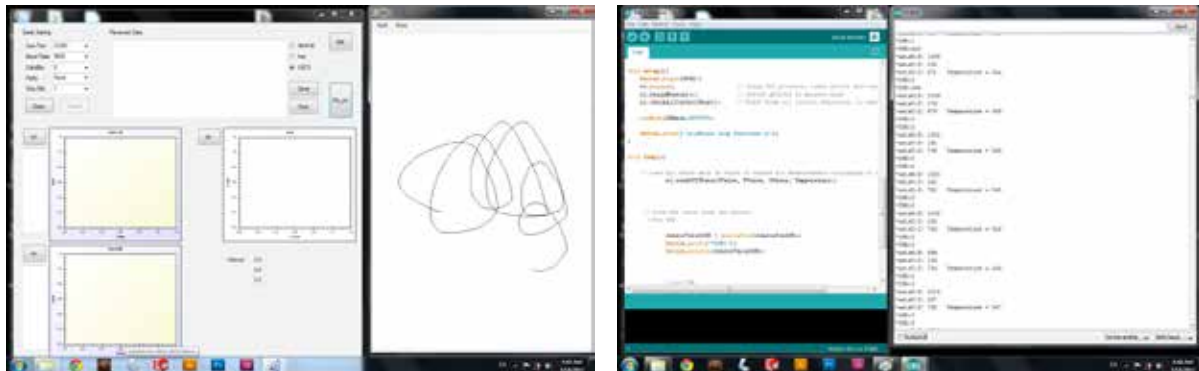


Connecting to the Arduino and testing electricity flow.

Figure 43. The failure to test program



- Each sensor detects and shows data
- Multi data from each sensor occur errors
- Fail to test program
- Optical mouse works well
- Further studies are required to develop program



Mobile application design

The emotional expression device collects data and sends data to the mobile application. The application can analyze the emotional state which was demonstrated in the previous chapter. This application will display the result of the analysis by visual information. The intent of the graphic design concept of mobile applications is to increase the degree of practical usage of information by schematization of complex data. Also, visualized information enables the users to understand their emotional state immediately and efficiently by time. The most important purpose of this application is that the users can confirm visualized information of their emotional state without any concerns being exposed to others. Thus, this application displays emotional state by different colors, different sizes of graphics, an

time. There are three drafts of the main page of the application. Among these, Draft #1 was chosen as the final application design because it provided information simply and curiously. The process that users confirm information through the application is as seen in Figure 45.

The collected and analyzed information is displayed in a different color and size along with the time information. The graphic, with specific colors, means the latest and not indicate the state of the emotion. This application shows the graphics with a unique color, which is set by the user. Therefore, the information of emotional state can be recognized only by the user. Moreover, the main page has been applied to Russell's Structure of two-dimensional model of emotion. Thus, each position of graphics is related to the emotional state. For more information, the user can go to the detail page by clicking graphics. The detail page contains the writing or drawing by using the emotional expression device. This page also shows a recommended list of music or photos which would help the user



Figure 44. Three drafts of the main page of the application

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be comfortable. The user can see this daily emotional state later through the calendar page.

Figure 48 shows the final design in use. The final design of this study is PEN+, including the digital emotional expression device, the charger, and the mobile application. The name of PEN+ means a pen, with new functions and the device and the application. There are more pictures of the final design.

Lastly, this section describes how PEN+ interacts with the user and the application. The interaction process can be divided into three different stages, which are expressing emotions, understanding emotions, and regulating emotions. In the expressing emotion stage, users interact with PEN+ to express their emotions by behavioral or written expression privately while in public. This stage can be regarded as the first step in regulating emotions. The second stage involves understanding the emotion phase. In this stage, users interact with PEN+ at first. While using PEN+, users are able to check their emotional states immediately via blinking lights. This period can be regarded as the second step for regulating emotions. The process of interacting with the mobile application also takes place during this stage. Users can gain analyzed information about their emotional states. Since the position of the device's graphics indicates one's emotional condition, users can understand their feelings quickly and easily. The last stage concerns the regulation of emotions. In this phase, users interact with the application. The app shows a color plate that is set by user preference to refresh emotions. Moreover, it recommends that users listen their favorite music on their smartphones and view photos on their Social Network Services (SNSs) in order to refresh their emotions.

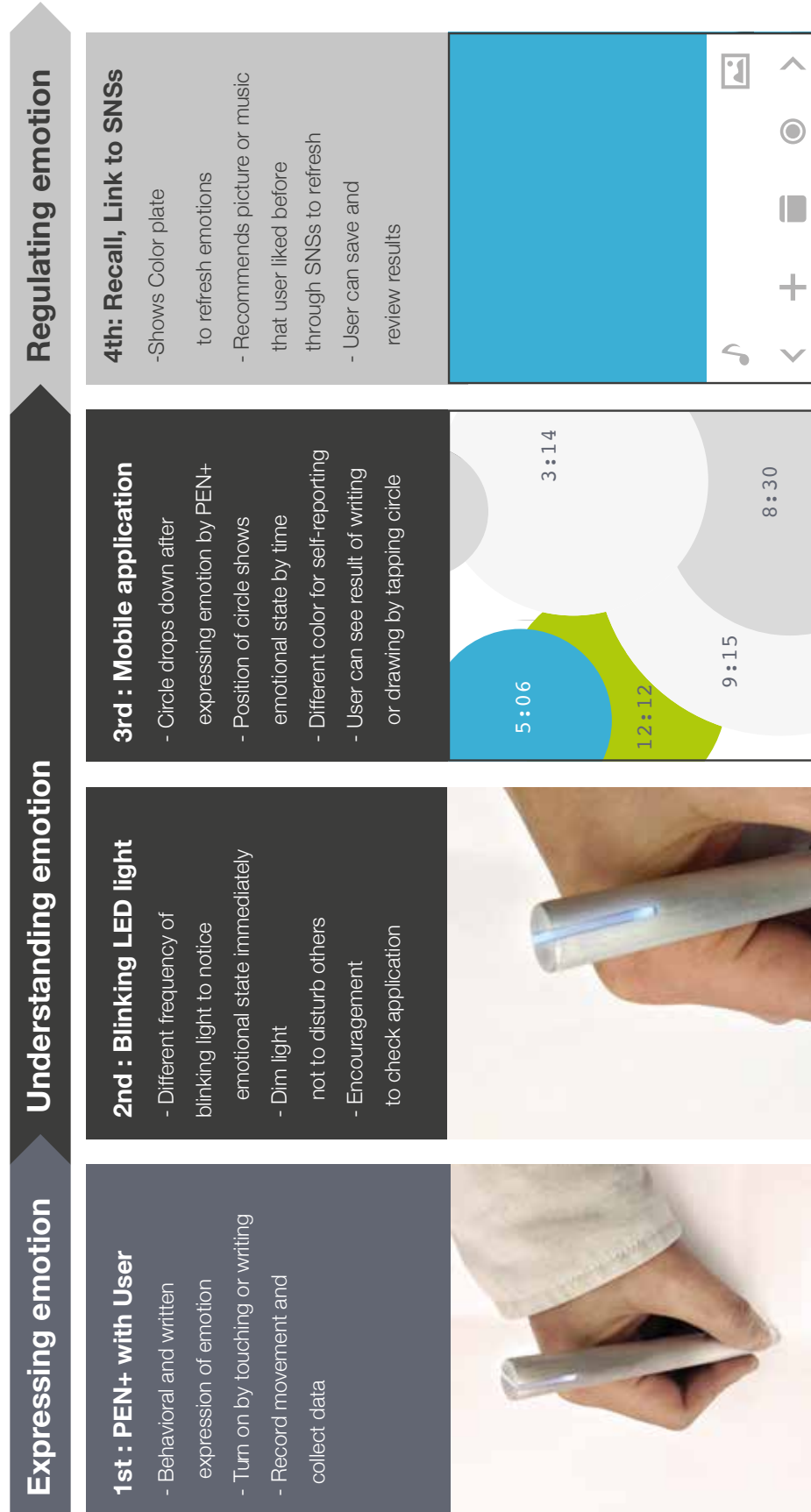


Figure 46. Interaction process with the final design

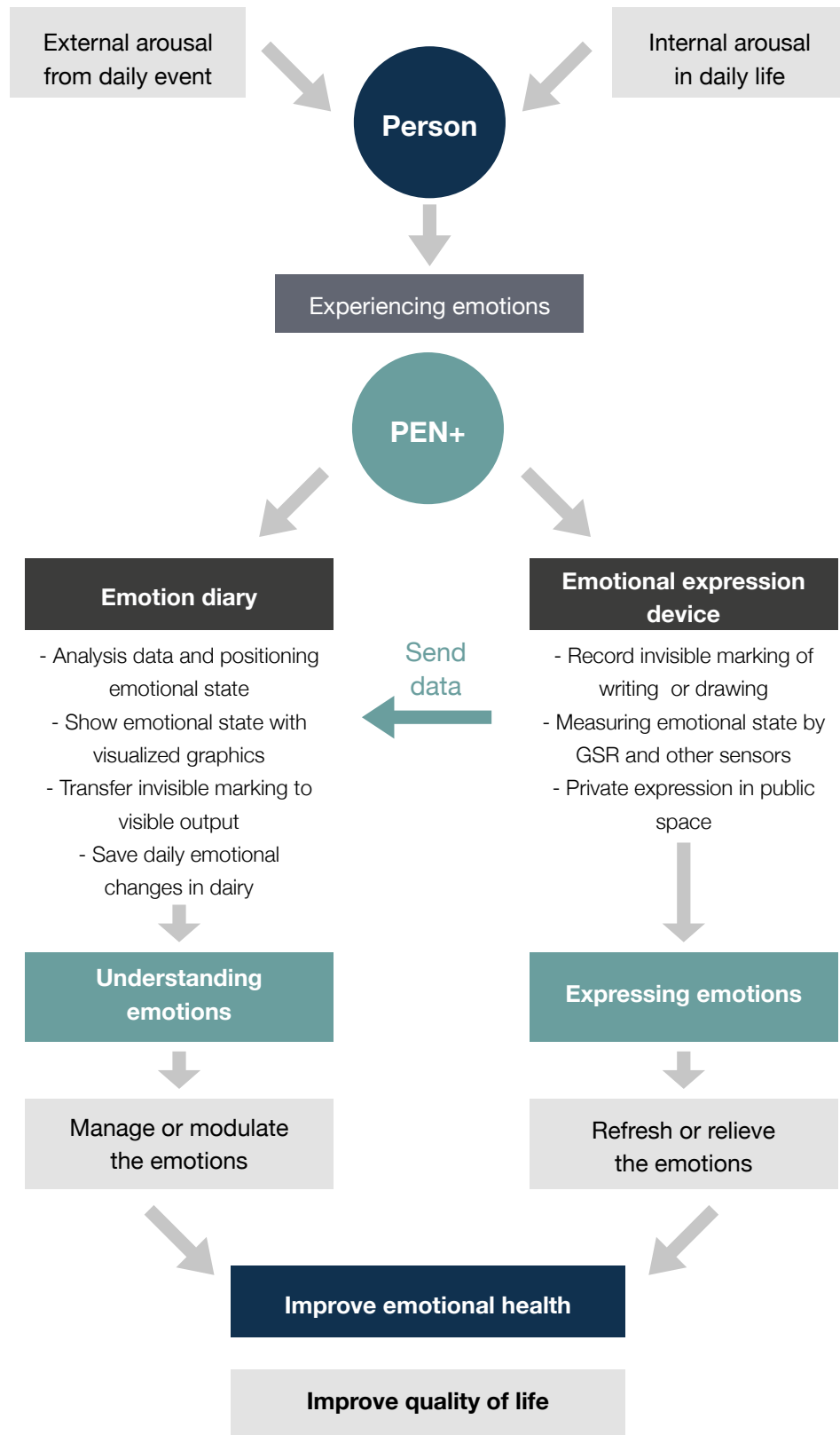


Figure 47. Overall process of the final design

**The final design
in use**



Figure 48. The final design in use





Figure 49. The final design in use 1



Figure 51. The photo of Thesis show



Chapter 07 : **Conclusion**



Chapter 07

: Conclusion

This study was based on personal questions about human emotions, and it aimed to explore various issues related to emotions. This study has described the definition of emotion, expression, and understanding of emotions, as well as the impacts of emotions, through a review of previous research. This study has also shown different methods to find user's needs and solvable problems: hypothetical user scenarios, observation, and survey.

Theoretical research and user research put forward a solution that proper understanding and expression of emotions are ways to improve emotional health in daily life. Moreover, design concepts were developed and evaluated under three subjects: easy visual interaction, private use in public, and usability and portability. Intriguing activities conducted in this study included various experimental explorations to consider the feasibility of the final design, such as connecting different sensors to measure the emotional state, playing with diverse shapes and forms, and making a mockup model. Thus, this study suggested PEN+, digital expression device, and mobile application as a final design that helps people to express emotions and to check their emotional status easily.

This study had some limits in technical implementation to execute a program with sensors and the absence of a clinical trial to prove a practical effect. While experimenting with a prototype designed and programmed by technical research, there are difficulties in collecting accurate and integrated data.

Moreover, the lack of analysis of the trial version and psychological therapists is a weak point of this study. Offering the opportunity to receive counseling through an online connection with recorded data from PEN+ is recommended for further investigations to understand

and validate the efficacy of this study better. For the next step, online connections with psychological therapists are recommended, and the recorded results and collected data should be sent to them.

Notwithstanding these limitations, this study proposes a new method for understanding and expressing emotions through personal device and application. This suggestion can be an opportunity to engage people's attention toward their emotional health.

This study has raised a fruitful approach to applying new digital features to familiar analog objects. The emotional expression device looks like a common writing tool in appearance and usage, but it has unique functions to measure emotional states and to record writing or drawing. The mobile application records emotional states, and data can be collected from the device as though a child were writing in his or her diary every day.

The core objective of this study was to describe the final design process to integrate and reinforce knowledge and information in various areas. This study suggests innovative and cohesive approaches to design to contribute to a better life.

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